**Digital Human Modeling and Simulation for Virtual Ergonomics Evaluation**

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**Lecture - 18**
**Application of Digital Human Modeling and Simulation in various Industrial sectors Part I**

In continuation of our earlier classes on Digital Human Modeling and Simulation for Virtual Ergonomic Evaluation; today we are going to discuss our week seventh module.

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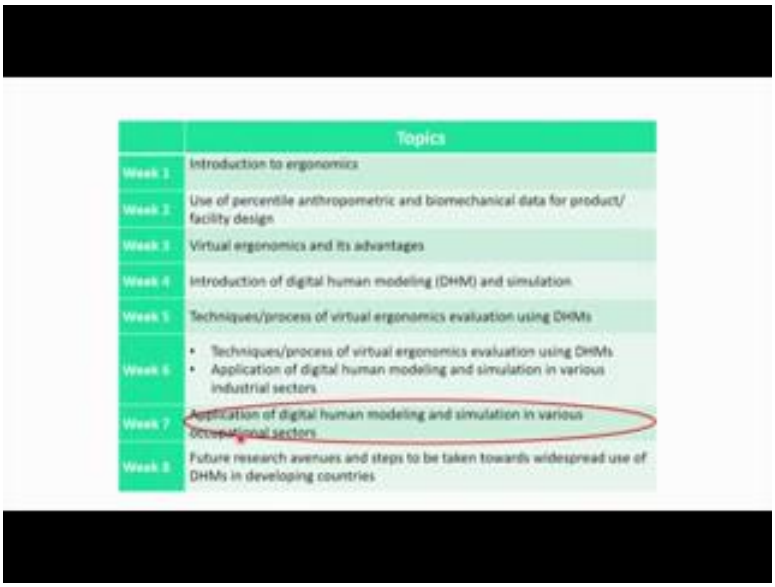


That is module 7; it is related to application of digital human modeling software in various occupational sector mainly, today we are discuss about application of DHM in agricultural sector.

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So, various application of DHM software in agricultural sector has been reported by various researchers. So, recently from a published paper by Patal et al, 2016 this paper is mainly (Refer Time: 01:10) paper, the title of the paper is ergonomics perspective in agriculture research a user centered approach using CAD and digital modeling technologies.

So, in this paper author mentioned that compared to other industry application of DHM technology has, come late into agriculture setting. So, while you find the digital human modeling software is been used in other industry like an aviation aerospace automobile industry from very beginning of its insertion, but in agricultural sector its application has been started late. Most of the available literature reported application of DHM in off road vehicles, specifically for tractor cab. Whatever application of the DHM software you can find in the find in the field of agriculture sector this are mainly related to off road vehicle and specifically tractor cab. Several researchers have applied computer aided simulation techniques for conducting human factor engineering analysis, like controllability, control comfort, and lumbar force on a new model of versatile agriculture, power carrier.

Papers related to application DHM in agricultural sector discuss about human tractor or power carrier interface design. As for example, well accommodated operators enclosures that is cabs and protection frames controllability of driving fields of vision drivers degree of comfort in driving location of various controls applications and features of DHM etc.

So, in most of these papers related to digital human modeling softwares application in agricultural sector deals with all this areas.

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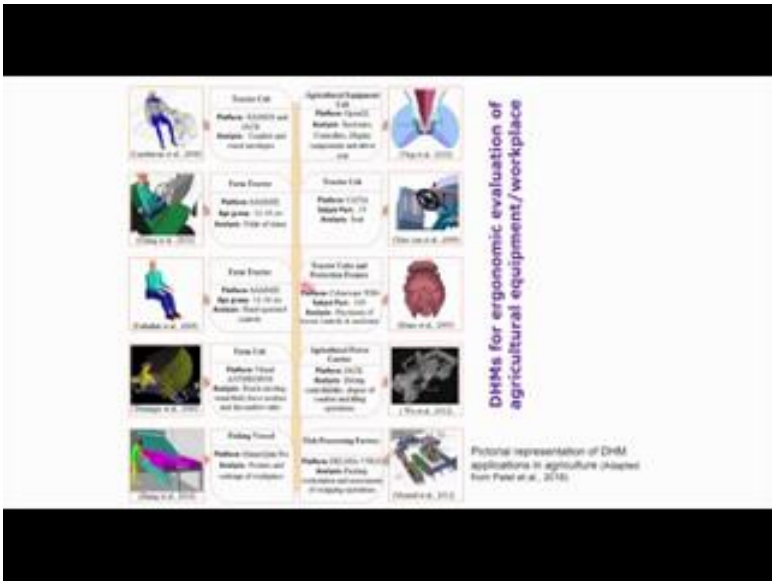


So, this image has been taken from the same paper Patal et al 2016 and in this paper, but in this image authors mentioned or tried to show through the images how the digital human modeling softwares are been used by various researchers in their research. So, we can see it has been used for tractor CAB design for farm tractor then milk agricultural power carrier fish processing factory for designing fishing.

So, in most of the cases all the references are provided in this image and which platform those researchers have used that is also mentioned which ergonomic issues they have considered in their analysis that is also mentioned here. So, from this image it is very clear that various researchers have already use digital human modeling software in the field of agriculture and also in the field of a fish processing industry.

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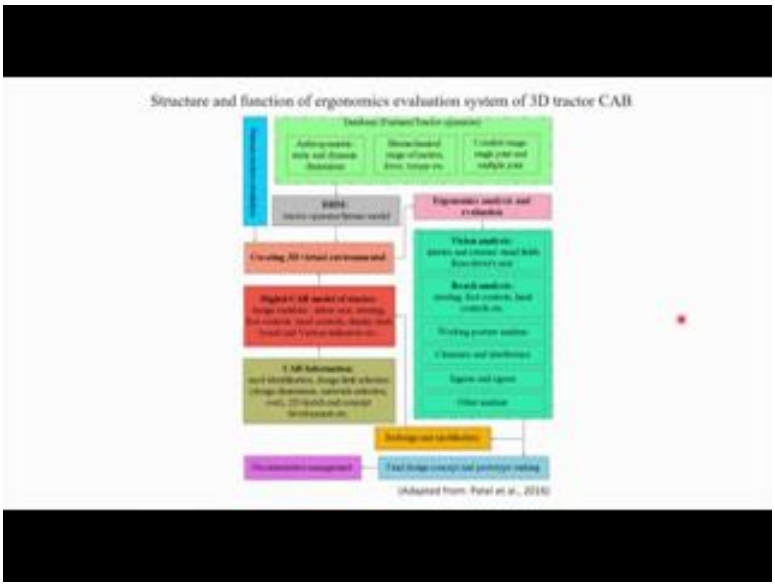


Now we are discussing this semantic diagram while the structure and function of ergonomic system of 3D tractor CAB has been explained. So, these are adopted from Patal et al 2016. So, in this schematic diagram author's mention that how 3D tractor CAB can be evaluated using digital human modeling software in virtual environment. So, first it is started from the requirement of database which database is required we require the database farmers or tractor operators. So, they are anthropometric data that is static and dynamic anthropometric that is required then, we require bio mechanical data related to range of motion force to all etcetera.

Similarly, comfort range single joint or multiple joint comfort data are also required. So, these are the database required for developing or creating the digital human model of tractor operator or farmer model. So, based on all the anthropometric biochemical comfort data we can create digital human model for tractor operator or farmer when this model is ready then you go for creating 3D virtual environment. How we create this 3D virtual. So, in one hand digital human model or digital manikin is ready on the other hand you have to create the digital CAB model of the tractor for that purpose first we are starting from this side. So, CAB information is required which are those information need identification design limit selection design dimension material selection cost two d sketches and concept development. So, all these information is required while this information is with us.

Then we can go for digital CAB model developing design variables for example, driver seats steering wheel and various control hand control display dash board. So, all these components are design then assembled and ultimately we create the three dimensional CAB model of the tractor cabin while digital human model is ready or manikin is ready at the same time cab, model is cab, model of the tractor is ready then both this things are being to the visual environment with proper interfacing while digital human modeling is intercept with the tractor CAB model then we go for various ergonomic evolution. So, these ergonomic evolutions include machine analysis that is interior or exterior visual field from driver seat then, we can go for each analysis each analysis for various controls like steering wheel foot controls hand controls they will go for postural analysis with various posture evolution tool are Rula Reba, was then you can analyze comfort discomfort you can analyze clearance interference.

We can study and various other ergonomic issues can be evaluated while this interface is ready mean that tractor CAB model interface it digital human model then following all these evaluation. If we find that everything is as per our requirement and there is no problem all that, are mean digital human model derived from the targeted region population you can operate all these function comfortably efficiently then we can for final desire finalization. Finalization of the design concept and we can go for prototype making and at the same time documentation.

But if we find there is some loop poles some design modification is required following these all these analysis. If we find the design modification is required then we have to go for design modification along the design modification will make the changes in the three dimensional tractor CAB model and again. We will go for the same loop evaluation and after that evaluation. If you find that everything is fine everything is acceptable has from the point of view of human factor then we can go for final protect development. So, from through these symmetric diagram authors mentioned that how digital human modeling software can be used for analyzing the tractor CAB from various considering various ergonomic accepts.

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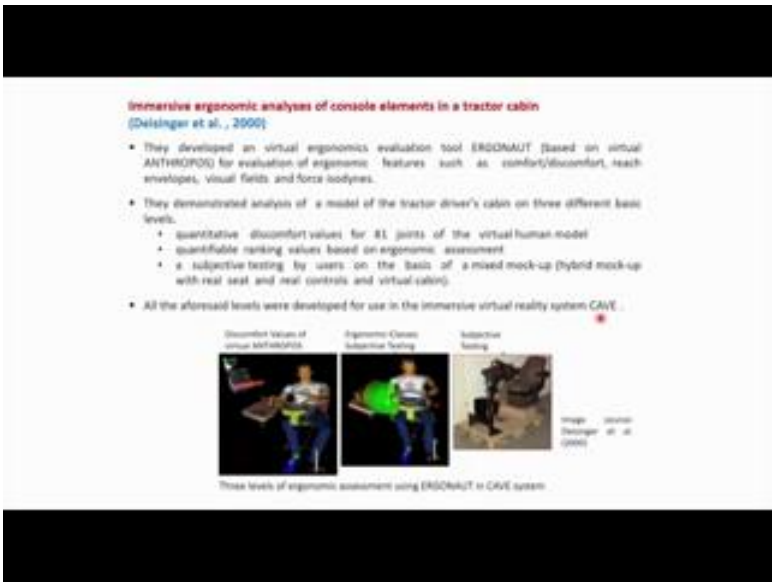


Now, we are going to discuss little research paper in the field of agriculture digital human modeling software has been effectively used. So, first paper he is entitled immersive ergonomic analysis of console element in a tractor cabin. So, authors Patal et al 2000. They developed an, virtual ergonomics evaluation tool ERGONAUT based on virtual Anthropos this is the earliest software based on this software they develop ERGONAUT for evolution of agronomic features such as comfort discomfort reach envelops visual fields and force Isodynes.

They demonstrate analysis of a model of the tractor driver's cabin on three different basic levels. So, first level is quantitative discomfort values for eighty one joint of the visual human model next quantifiable ranking values based on ergonomic assessment.

Third level is the a subjective testing by the users on the basis of a mixed mock up hybrid mock up and real seat and real controls and virtual cabin. So, in this particular research they not only conducted the research in virtual environment with digital human modeling software at the same time with real subject they, get the they collected the feedback using the hybrid mock up and real seat and real's controls are used in the virtual work space environment all levels were developed for use in immersive virtual reality system that is cave.

So, here from this image it is seen that this is the discomfort values of virtual and suppose that can be evaluated. Then various ergonomic analysis ergonomic classes

subjective testing and last one is the real set up for with seat and steering wheels, were real human can sit and you can interrupt with the CAD generated virtual environment, but these components are real. So, these actually used for subjective evaluation and the real subject can seat and they can give their feedback based on the input received from the virtual environment.

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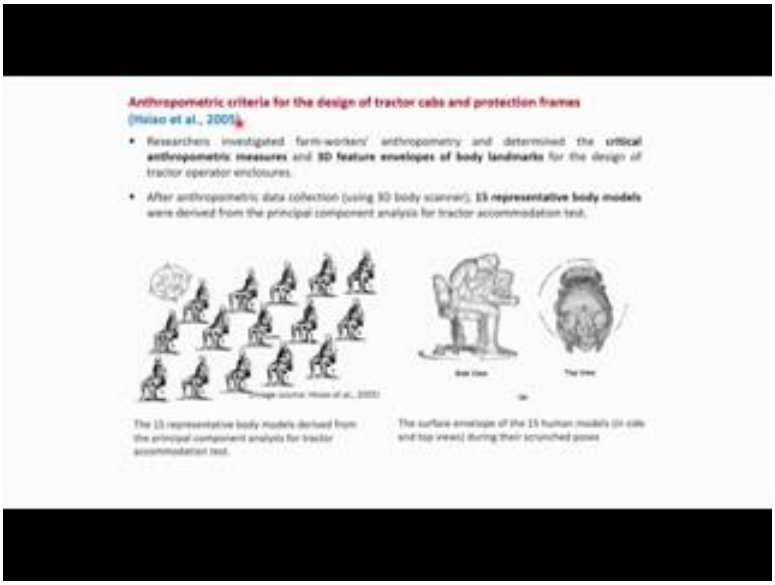


Et al 2005 in their paper anthropometric criteria for the design of tractor cabs and protection frames in this paper researcher investigated farm, workers anthropometry and determine the critical anthropometric measures and three dimensional features envelopes of body landmarks for designing the tractor operator enclosures after anthropometric data collection using 3D body scanner fifteen representative body models.

Were derived from the principal component analysis for tractor accommodation test, these are the 50 representative body models derived from the principal component analysis for tractor accommodation test and in this image we can see the surface envelop of the fifteen human models. So, 15 human models are positioned on the seat and the surface envelop that how much area is required for accommodating the various different types of human models in there is variation anthropometric variation for 50 models how much spaces required and how much is the variation. So, this is the surface envelop for fifteen human models. So, this is from side view this is from top view.

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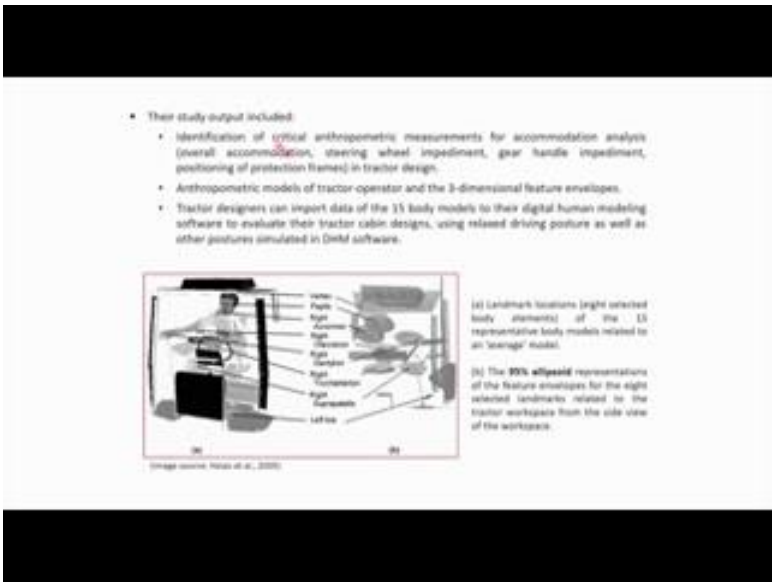


Their study output included first identification of critical anthropometric measurements for accommodation analysis these accommodation analysis included overall accommodation. Steering wheel impediment gear handle impediment positioning of protection frames in tractor design anthropometric models of tractor operator and the three dimensional feature envelop are also derived tractor designer can import data of the fifteen body models have seen in the earlier image.

So, these 50 model its anthropometric data. So, these 50 body model any designer any engineer can import those human models in their respective digital human modeling software for evaluation tractor design or tractor CAB design using relaxed driving postures as well as from many other posture which designer can simulate with the help of digital human modeling software. So, actually from this study getting this 15, digital human models and those models can be used for further study.

So, if you look at this image on left side it is show landmark location 8 selected body elements these are the 8 selected body elements for 8 selected body elements. These are the land marks of the 15 representative body models related to average models these is the average model around that average model for each of the land marks. How will be the distribution of the landmark dispersion for 15 number of human model that is show here on the other hand, on the right side this image be it is showing the 95 percent

ellipsoid representations of the future envelops for the eight selected land marks to the tractor work space from side view of the workspace.

So, from side view for each the landmark. So, this is the left pro for fifteen human models how should be the position of the left side. So, that is the further similarly for the vertex. So, this is the area for to cover 95 percent this is the 95 percent ellipsoid it means 95 percent of the population vertex is covered within this area.

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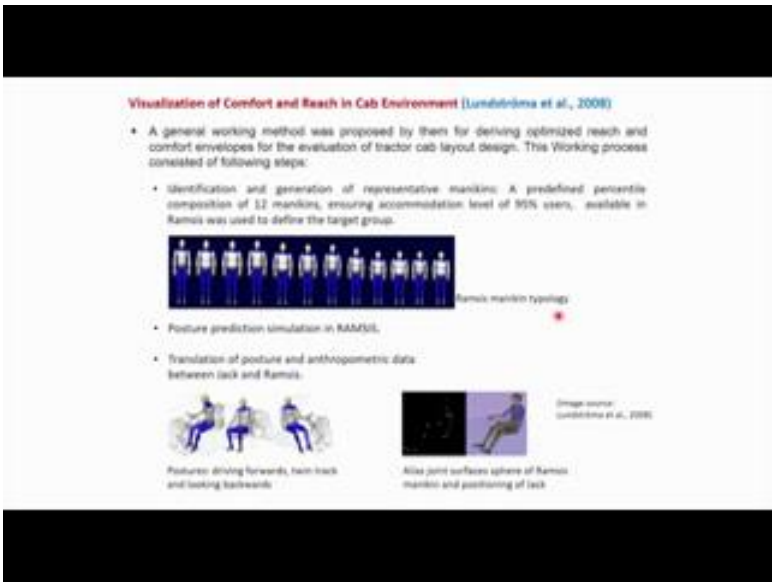


Next (Refer Time: 15:35) et al 2008 in their paper visualization of comfort and reach in CAB environment they proposed a general working method for deriving optimized reach and comfort envelops for the evaluation of tractor CAB layout design this paper is also related to tractor CAB layout design and they proposed a working methodology the working process considered the following steps.

The step was identification of generation of representative manikins a predefined percentile composition of 12 manikins ensuring accommodation of 95 percent users available from RAMSIS software was used for worst, has the used to define target group as the target group as the target user population they selected twelve manikins from RAMSIS topology in RAMSIS software these twelve manikin are predefined and these 12 manikins are actually developed from percentile composition of predefined percentile composition and it can covers 95 percent of the users. If the facilities evaluated with this twelve human model and then you can assume that the facility can be used by 95 percent

of the user because these 12 manikins, actually comprised of different percentile body dimension which is represented of 95 percent of the population.

Then posture prediction is done using RAMSIS software next step translation of posture and anthropometric data are between from RAMSIS software to jack software. So, from this posture was given posture prediction was made and the posture and anthropometric data was transferred from RAMSIS software to jack software. So, here from this image you can see driving forward to interrupt and looking backward. So, these are similar to its RAMSIS software after that Allies joint surfaces sphere of RAMSIS manikin and positioning of jack. So, from these models these body landmarks are extracted and based on those body land mark jack human models are given a particular posture.

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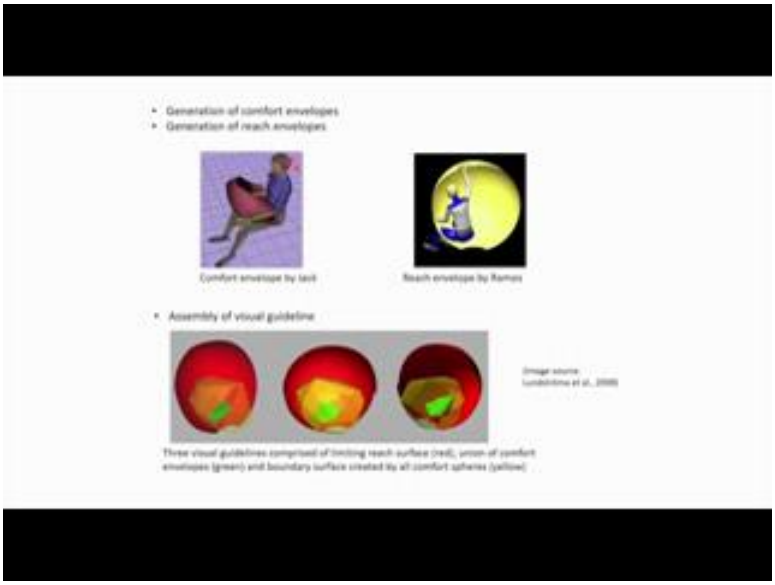


Then various ergonomic evolution was performed which include generation of comfort envelops generation of reach envelops. So, here it is shown that comfort envelop for human model. So, this is the comfort zone for handle operation.

Similarly, this is the reach envelop using RAMSIS software and next they went for assembly of visual guideline. So, from these image we consider see color codings are there rate for the limiting resurface red one is for resurface, limiting yellow one is the all comfort sphere for 12 manikins the combined comfort sphere is this reliable portion and the green portion is actually the common envelops or union of comfort envelops that is repainted in green color. So, the union of comfort envelops for twelve repainted manikins

this one is the combination of all comfort spheres for the 12 manikins and the last one is the limiting reach envelop what its surface.

So, in this way following this methodology; that means, they develop the methodology they have showed that this type of using a group of manikin they can transfer the posture from one software to another software and ultimate they can go for various type of ergonomic evolution for tractor CAB designing.

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In the next paper by Xiao Yan et al 2009 the title of the paper is expert system for tractor CAB man machine interface evaluation in this paper, researcher developed an expert system using C++, and clips and the system, can be used to evaluate man machine interface of tractor CAB quickly and find the short coming in the design. And if it can be identified according the design modification is possible effectiveness of this expert system was demonstrated through evolution of tractor model in the reported research Xiao Yan Er Al 2009 presented the structure and functions of the system they also put forward the knowledge expression reason mechanism and the design and build method of knowledge base.

Now, if you look at the image it is showing the digital human model seated on the tractor cabin seat and operating the controls. So, this expert system was ultimately they, demonstrated that these expert systems can be used for tractor CAB design and design modification.

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Fathallah et al 2009 in the research paper entitled ability of youth operators to reach farm tractor controls the researcher investigated the abilities of youth operators with varying age and anthropometric characteristics to reach farm tractors controls on 25 tractors which are common in use in USA using Sammie CAD software. So, in this particular research paper they investigated that whether the youth operators the actually the tractor and tractor cabin design for adult population.

But whether that tractor can be suitable of youth operator they studied using Sammie CAD software it was observed that many tractor controls especially those that are hand operator may not be effectively reached by the majority of the youth operator within the age group of 12 to 16 years. They are study finding these supported the establishment and refinement of policies and guidelines related to the youth tractor operations researcher stated that the approach of ergonomics evaluation using CAD software as demonstrated in present research would be applied in similar situation where youth operators are involved.

So, now these are few steps how this analysis has been done. So, from the original tractor using marking then they derive this type of model data points for developing the CAD model of the tractor. So, for this purpose they use photo modular software. So, in this image it is showing photo modular showing steps towards resulting special representation of the tractor. So, from the marker tested on the tractor. So, they took

images or photograph from different angles and based on those images with the software photo modular they derive this type of CAB model. So, properly scale three dimensional virtual tractor mock up was developed using photo modular software then that model was evaluated using Sammie CAD software with the semi CAD software virtual 3D human was developed and that was interpret with this CAD model of the tractor and various types of ergonomic evolution was performed.

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So, in next research paper title of this research paper is design of agricultural equipment CAB based on virtual reality. So, this was reported by Ying et al 2010 here the researcher have used OpenGL 3D graphics software for designing the tractor and combine harvester 3D cabs the cabs are evaluated by 50th percentile manikin all though it was possible to evaluate with 50th and ninetieth percentile for representing various body dimensions of visual population, it would has been possible, but particularly in this research paper they used only authors are used only 5th percentile manikin in virtual environment using combination of OpenGL and virtual software multigene vega prime.

They describe the development of virtual design system for agricultural equipment CAB with the following steps. So, this virtual design system what they proposed it actually to follow this steps, first step developing parametrized model of agricultural equipment CAB with all its components those components are enclosures hand controllers foot controllers display components and driver seat. So, these was develop with OpenGL

software designing data regarding human machine interface in agricultural equipment cab, were managed by linked list and transferred from host computer to virtual reality system for vivid display and subjective evaluation by socket mechanism or socket method in the virtual reality system parametrized model. Where displayed by involving the mixture of virtual reality software that is multigene vega prime and modeling language OpenGL.

Next a virtual design system was established based on ergonomics theory design criteria and virtual reality technology for the evolution of the agricultural equipment cab. Finally, a tractor CAB and a combine harvester CAB were designed and evaluated with this system or demonstration of the effectiveness of the proposed system that is virtual design system. So, with this example of tractor CAB and a combine harvester they demonstrated how the software is effective and how it can be used.

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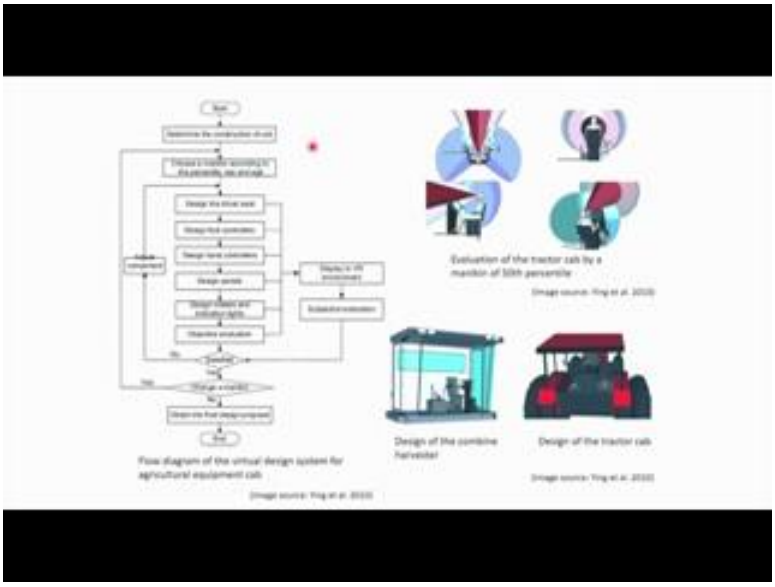


So, here are the step that how the system works. So, start determine the construction of the CAB choose the manikin according to the percentile is 6 then, design the driver seat design the controller design the foot controller hand controller design panels design meters and indicator lights objective evaluation. You need to follow all these step and these to be dissipative virtual reality environment for subjective evaluation, one side using this type of digital human modeling softwares. Where you can put digital human

model software and we can perform various type of evaluation using 5th percentile manikin.

On the other hand for getting the subjective in subjective rating subjective perception the same this CAB model of the components and the overall tractor CAB was painted in virtual reality environment to the real subject for subject evaluation. If it is found satisfactory from both the accepts from virtual analysis and has virtual simulation analysis has well has from subjective evaluation in virtual reality system if in both the system, if in both the situation it is find satisfy then we can go for change a manikin.

So, if it is analyzed $5^{th}$, 50th percentile then we can go for analyzing another manikin, if it is found that no obtain the final design proposal, if it is find a no there is no changes is required then we can go for final design proposal and there will be end of the process and if you find that there is some if it is not satisfied then, we go for adjustment of the components and again will come to this step. If it is found satisfied then we will go towards the end and we will go for change even with after evaluation with particular manikin or particular human subject if you find it is satisfied then again we can analyze it with different manikin and again we can follow this steps.

So, in this way following this semantic diagram they repainted the how that they are virtual system works. So, following the using these systems they are ultimately are mentioned in the earlier slide also. So, they design a combine harvester and also tractor cab.

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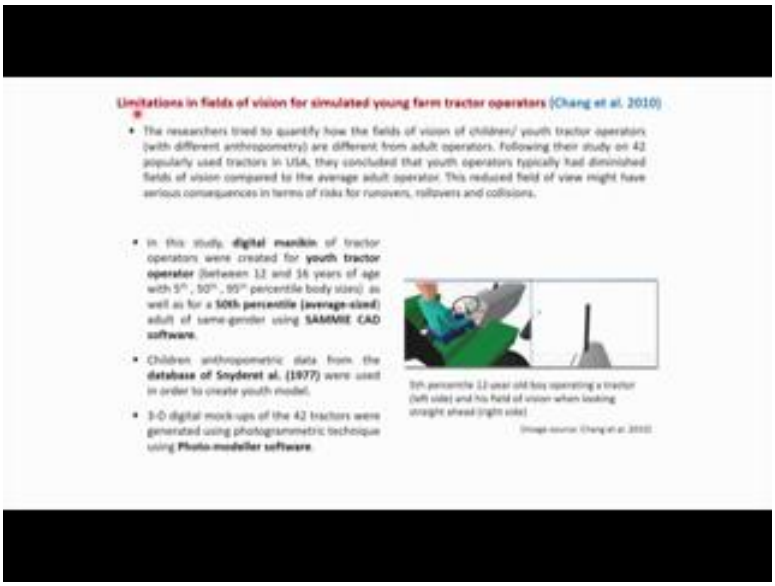


In the next paper is limitations in fields of vision for simulated young farm tractor operators this was reported by Chang Et Al 2010, the researcher tried to quantify how the field of vision of children or youth tractor operator, who were wearing anthropometric and who is anthropometric defined from the adult population. So, researcher tried to quantify how the field of vision is defined for the children or youth operator following their study on forty popularly used tractor in USA, they concluded that youth operators typically had diminished field of vision compared to the average adult operator this reduced field of view might have serious consequences in terms of risk for run overs rollovers and collisions because this farm tractors are actually designed for adult population.

But in USA particularly it is seen that youth are children are operating those farm tractors while they operating what type of problem they face in terms of visual view feel or visual. That was adjusting in this particular research paper. So, in this study digital manikin of tractor operator were, created for youth tractor operator whose age range is between 12 to 16 years and 15th and 1950 percentile model are created using Sammie CAD software for the children model.

Similarly, with the Sammie CAD software 50 percentile average size adult human model of same gender either male or female also created for comparison children anthropometric data from the database of Snyder et al nineteen seventy seven were used

for developing the children manikin of 50 and 95 percentile three dimensional digital mock up of the 42 tractors are generated using photogrammetric technique using photo modular software.

So, in this image we can see 5th percentile, 12 years old boy operating a tractor this is the left side image and right side image while he is looking forward or straight ahead how much is the visibility in the view field what object they can see.

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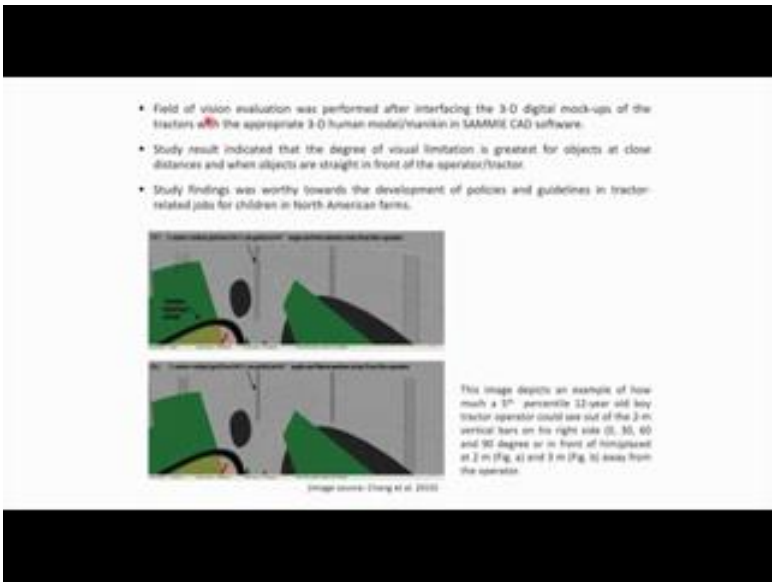


Field up vision evaluation was performed after interfacing the three dimensional digital mocks up of the tractor with the appropriate human model or manikin either the children module or adult module study result indicated that the degree of visual limitation is greatest for objects at close distance, and when the objects are straight in front of the operator. So, visual limitation is more while that object are closure or it is straight forward study finding was worthy towards the development of polices and guidelines in tractor related job for children in North American farms.

So, if you look at these two images upper and lower images. So, the upper one is the depicts an example how much of 5th percentile, 12 years old boy tractor operator could see out of 2 meter vertical buts. So, 2 meter vertical buts are position in front of the tractors and from the driver's seat a 12 year boy how much area are how much portion of the this buts are visible to the operators it was studied. So, can see 2 meter vertical, these

buts are off to meter verticals and these are position at 0 degree at just in front and 30 degree, 60 degree and 90 degree in right side.

Similarly, while those vertical buts are positioned at three meter distance then how is the visibility that is depicted in the bottom image? So, in this particular study researcher clearly showed that for the else the tractor was originally designed for adult population while these tractors are been operated by children or youth population. Then their visibility is actually reduced and due to this less visibility there is the chance of accident and these information is very important he developing the policies.

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Wu et al 2012 in their research paper computer aided human factor engineering analysis for a versatile agriculture power carrier the researcher studied the human factor related problem of the power carrier through computer aided simulation analysis technique.

So, in this research paper researcher used digital human modeling. So, in this research paper researcher studied the human factor related problem of the power carrier through computer aided simulation analysis technique. CAD software packages solid works and ideas are used to develop the computer model of the power carrier. So, two software; they were used solid works has well has ideas for developing the CAD model of the power carrier human model of 5th, 50th and 9th percentile male and female were developed from the Taiwanese labor anthropometric database using jack software.

So, using jack software they develop different percentile human model for both male and female from the Taiwanese labor anthropometric database, they address the issues to controllability of driving driver's degree of comfort in driving and the lumbar force condition of the operator while lifting cargo from the cargo bench of the carrier.

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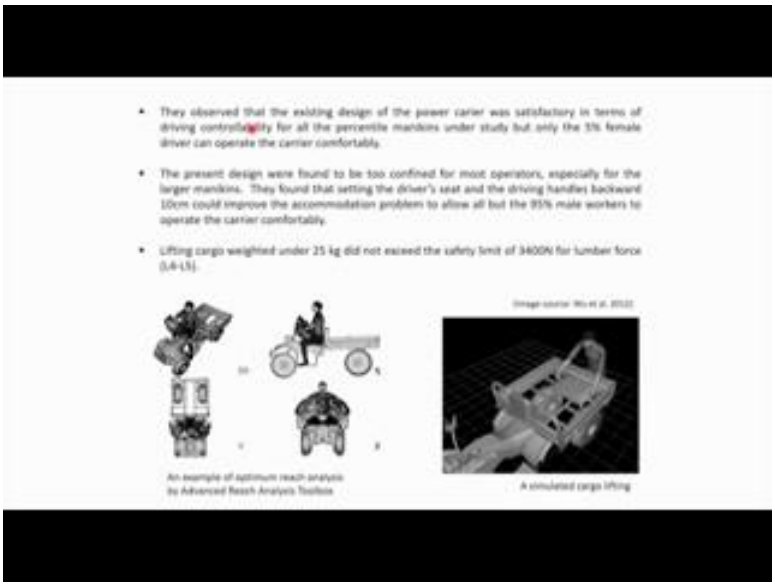


So, these various ergonomics aspects or human factor issues they for this type of various task they analyze the human factor issues they observed that the existing design of the power carrier was satisfactory in terms of driving controllability for all percentile manikin means starting from 5th to 95 percentile under study, but only 5 percent female driver can operate the carrier comfortability see in terms of comfort is not actually acceptable for wide range of the targeted population, but from driving control controllability it is acceptability for the entire range of the population the present design was found to be too confined for most operators especially for large manikins they found that the setting the setting of the driver's seat and the driving handles backward by 10 centimeters could improve the accommodation problem to allow all, but the 95 percent male workers to operate the carrier comfortably lifting cargo, weight under 25 kg did not exceed the limit of 3400 Newton for that is the safety limit for lumbar compression l4 l5 lumbar compression.

So, from these study it was observed that if the while the operators are handling only 25 kg load then there is no risk, but if again they proposed if that its lifting cargo height can

be increased little bit then there is less force the force can be reduced the spinal final compression for that l 4 l 5 level can be reduced by design modification of the lifting cargo. So, these are one example of optimal reach analysis by advanced reach analysis tool. So, this is from front view and this is from top view this is from side view. So, here it is shown how cargo lifting is done.

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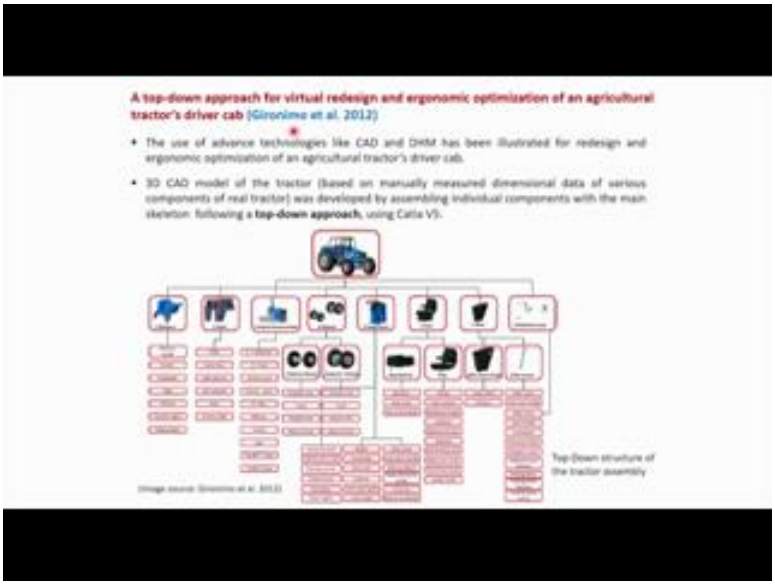


So, in the next paper is a top down approach for virtual redesign and ergonomic optimization of an agricultural tractors driver, CAB this was reported by Geronimo et al 2012. So, in their paper or in their research, Geronimo et al 2013 they used advanced technologies like CAD DHM for illustrating the redesign and ergonomic optimization of an agricultural tractors driver CAB 3D CAD model of the tractor based on manually measured dimensional data of various components of real tractor was developed by assembling individual components with the main skeleton following top down approach using CATIA v5 software. So, here it is shown that how these top down structure works. So, this is the basic tractor CAB model in the tractor CAB model individual components or sub components are installed to get the actual environment of the tractor cabin.

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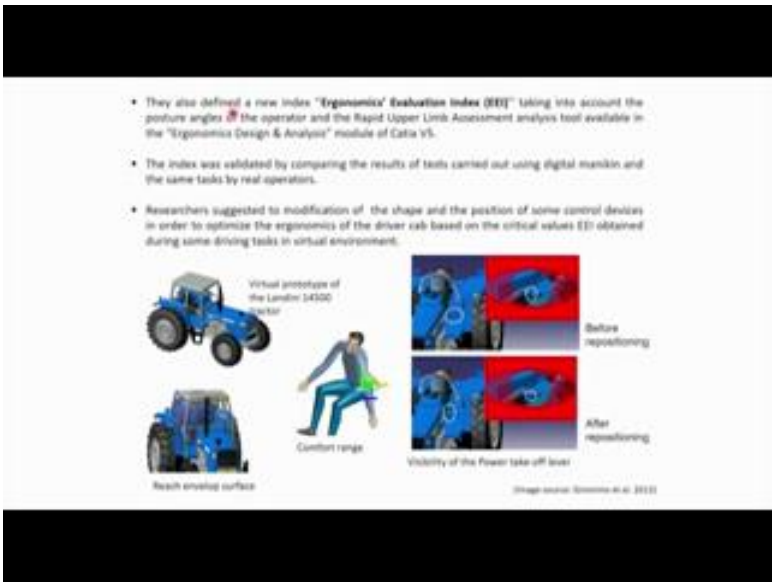


So, they also defined the new indexed called ergonomics evaluation index EEI taking into account the posture angles of the operator and the rapid upper limit assessment analysis tool available in the ergonomics design analysis module of CATIA v5 software. So, based on the ruler analysis rapid upper limb analysis and posture angle they develop this ergonomics evaluation index the index was, validated by comparing the result of test carried out using digital manikin has well has the same task by real operators researchers suggested to modification of the shapes, and the position of the same control devices in order to optimize the ergonomics of the driver CAB based on the critical values of ergonomics evolution index obtained during some driving tasks in virtual environment.

So, it is we can see virtual prototype of the tractor then how rich evolution is been performed then comfort range for particular body joint then position of various type of controls and based on the position whether the operator can visualize that control that is coming in separated window. So, these is before repositioning in the existing scenario only this much is this visibility, but while it was after repositioning while it was repositioned then it was easier to visualize the control the operator. So, in this the various ergonomics software of control location or control position was studied in this research.

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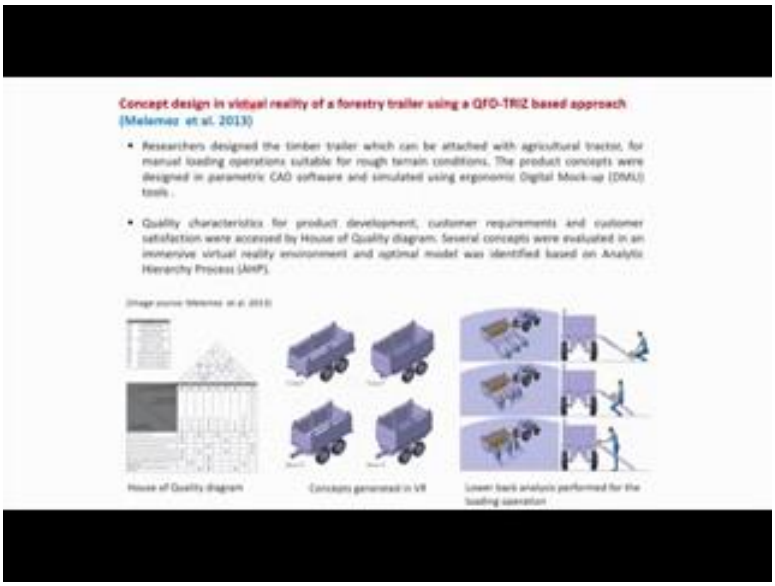


So, next paper is concept design in virtual reality of a forestry trailer using a based approach these research was reported by Melemez et al 2013 researcher designed the timber trailer which can be attached with the agriculture tractor for manual loading operation suitable for rough terrain conditions, the product concepts were designed in parametric CAD software and simulated using ergonomic digital mock up tools quality characteristics, for product development customers requirements and customer satisfaction were accessed by house of quality diagram several concepts are evaluated in an immersive virtual reality environment and optimal module was identified based on the analytic hierarchy process.

So, in this particular process using virtual reality environment as well has various others quality characteristics of product development analysis. Like analytic hierarchy process they identified the optimal solution this image is showing how house of quality diagram then concept generated in virtual reality system and in this particular paper lower back analysis was performed for the loading operation. So, while these timbers are being loaded in the carrier then, their low back analysis was their low back compression force was analyzed.

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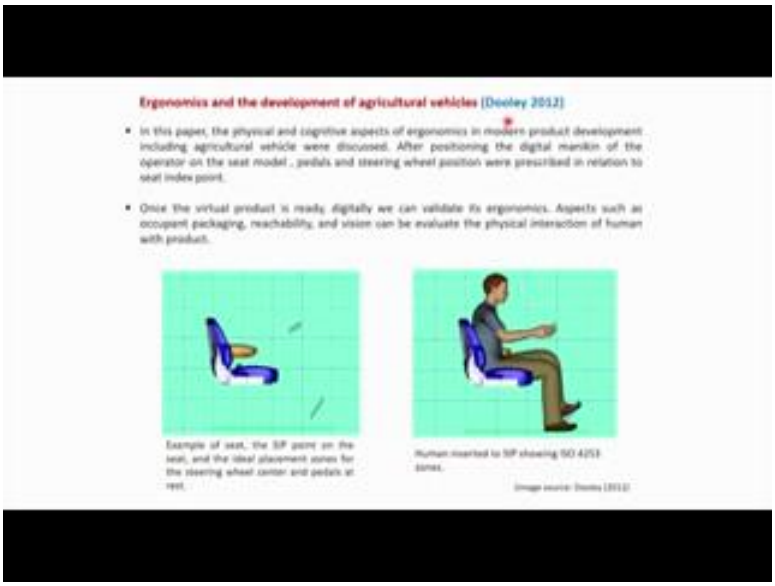


Dooley 2012, in his research paper ergonomics and the development of agricultural vehicles Ahthey, researcher mentioned about the physical and cognitive aspects of ergonomics in modern product development including agricultural vehicle. So, that has been actually discussed in this research paper after positioning the digital manikin of the operator on the seat model pedals steering wheel position, were prescribed to in relation to the seat index point. So, after positioning digital human model in the seat and based on the posture researcher defined higher should be the pedals and the steering wheel in relation to the seat index point once the virtual product is ready digitally, we can validate the ergonomics has mentioned by the researcher aspects such as occupant packaging reachability and vision can be evaluate can be evaluated the physical interaction of human with product.

So, here it is shown the example of the index point of the seat and the ideal placement zones for the steering wheel center and pedals at rest. So, these is the pedal position and this is the steering wheel position integration to the seating next point and while at the same time while it is, while digital human model position human inserted to the seat index point and showing various ISO 4 2 5 3 zones for various controls and its optimal location.

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Yang et al 2013, in the research paper ergonomic evaluation method of tractor CAB based on pro e manikin in this research paper researchers demonstrated the successful use of virtual ergonomic evaluation using digital mock up and manikin to accommodate wide range of targeted population with varying anthropometric that is from 5th percentile to ninety 5th percentile body dimension.

They redefined position of the hip point of a tractor CAB and evaluated sitting comfort vision performance and operational activities by inserting Chinese, male module developed by pro e manikin in the 3D CAB model ranges for optimal position of various controls from acceleration heal point for easy operation were identified along with the provision for maximizing visual performance. So, these are various images taken from the particular research paper and here it is shown manipulating steering wheel, that how the digital human model has been positioned in the tractor cabin and varies types of operation is been performed using steering wheel manipulating the lift control liver operation front console vision for the horizontal plane manipulating gear liver. So, various activities performed by the tractor operator can be evaluated during this pro e manikin and that has been demonstrated in the particular research paper.

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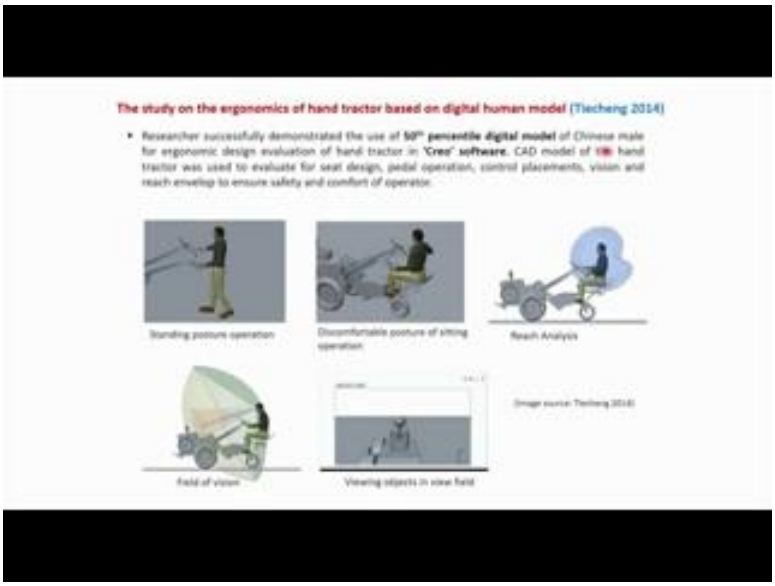


The next paper is reported by Tiechang 2014, title of the research paper is the study on the ergonomic of hand tractor based on digital human model.

So, in these research paper researcher successfully demonstrated the use of 50 percentile digital model of Chinese male for ergonomic design evaluation of hand tractor and they use Creo software CAD model of hand tractor was developed was use to evaluate seat design pedal operation control placement vision and reach envelop to ensure safety and comfort of the operators. So, has it is mentioned using the Creo software. So, that the Creo software was used for both developing the CAD module of the hand tractor has well has for developing the human model.

So, there is also human module the Creo software based on that human module they develop this human module and manikins and the evolution they perform, only for the 50th percentile digital model and various aspects they studied that is they evaluated reach they evaluated vision sorry, tatiechang evaluate evaluated reach vision then in this image we can see how much the while is the operator is looking in front that how much portion of his actually coming in his view field. So, these are the objects coming inside the view field similarly discomfortable posture in seating operation. So, these aspects are studied by you.

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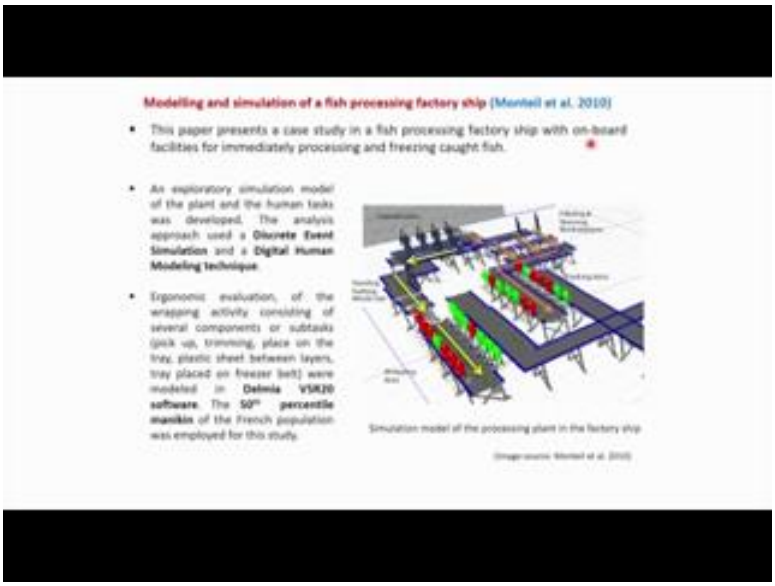


So, now we have discussing the next paper by Montell et al 2010 and the title of the paper is Modelling and simulation of a fish processing factory ship this paper present a case study in a fish processing factory ship with on based facilities for immediately processing and freezing of caught fish. So, this is the overall layout of the workspace of varies task has been performed in various groups. So, this is that fish processing factory and this is also on the fishing resell.

So, an exploratory simulation model of the plant and human task was developed by the researchers the analysis approach used discrete event simulation has well as digital human Modelling techniques. So, they use discrete event simulation for studying various aspects related to time study related to individual workstation evaluation, but this is for more general purpose, but for particular work station considering various aspects they use digital human Modelling techniques ergonomic evolution of the wrapping activity consisting of several components of subtasks like pick up training place on the tray plastic sheet between layers tray placed on freezer belt were modeled in Delmia v5 software and the 50th percentile of the manikin of the French fisher man are developed using this Delmia v5 software and that model possible for ergonomic evaluation of wrapping activity.

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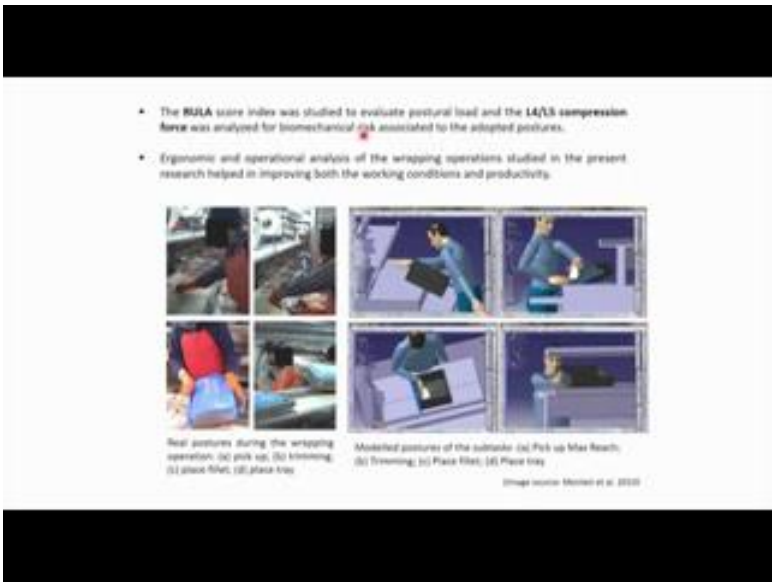


So, varies ergonomic aspects like the Rula score index l 4 l 5, final compression force analysis for biomechanical risk analysis. Were, performed by the researchers ergonomic and operation analysis of the wrapping operations studied in the present research help in improving both the working condition and productivity.

So, if these image these four images actually depicting the real working scenario in the raping process. So, real posture during the raping operation. So, fast they are picking up the plastic then cutting that or trimming then raping and then ultimately place the tray the same activities are simulated using Delmia software, and here it is shown the same activity like pick up cutting placing and ultimately placed the tray. So, place the filet and ultimately place the tray in the. So, that is shown here. So, this evaluation is very important because it helped in improving both the working conditions in that factory on the freezing vessel and also to improve its productivity.

So, in earlier paper we discussed about the application of digital human modeling software in agricultural sector particularly you can find that the most of the application are related to tractor CAB design or agricultural power carrier design not only this agricultural sectors. So, from this research paper we can see digital human modeling is also being used for fish processing industry also.

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The next paper is also related to fish processing fishing vessel. So, title of this paper is using anthropometric DHM prevention of occupational hazards on board fishing vessel this was reported by Zhang et al 2010 this research was carried out towards improving the occupational health and safety of Spanish fisherman and for redesigning the workspace of on board small fishing vessels the work postures of all the fisherman were a h fisherman simulated and assessed by using an ergonomic digital human model system. So, they used manikin pro software. So, first they studied the activity they performed in that small fishing vessel for fish processing those are studied problems is identified.

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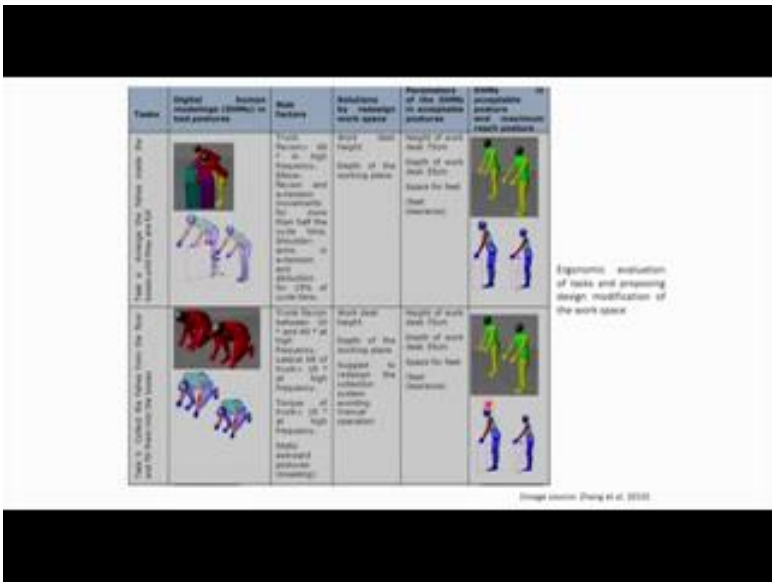


And those were simulated in digital human modeling software using manikin pro this manikin pro software.

So, in that research paper in the tabular form they printed how design modification is specified first the evaluation with digital human modeling software and how modification of the workstation can be done to obtain better posture of the fisherman or persons were involved there in various activities. So, in the first column they explain various tasks. So, here only two tasks are shown, but there are actually three basic tasks. So, task are shown first column then digital human modeling with back posture in the existing scenario what type of posture they are adopting. Why in those posture various risk are associated that is mentioned in the third column then what type of solution can be provided that is given here and parameters of the digital human model in acceptable postures how posture can be improved and this is the finally, it is shown that how posture is improved after that design modification.

So, in this way researcher demonstrated very nicely that digital human modeling software can be used for improving the working condition in those small fishing vessel.

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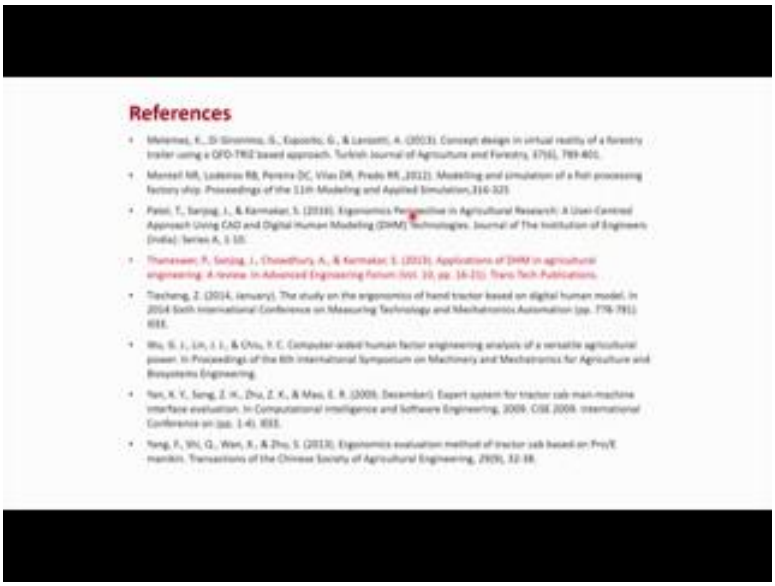


So, these are the list of references which have been used in various slides. So, we can go through this research paper for getting more information related to this particular topic application of digital human modeling software in agriculture sector these are remaining references.

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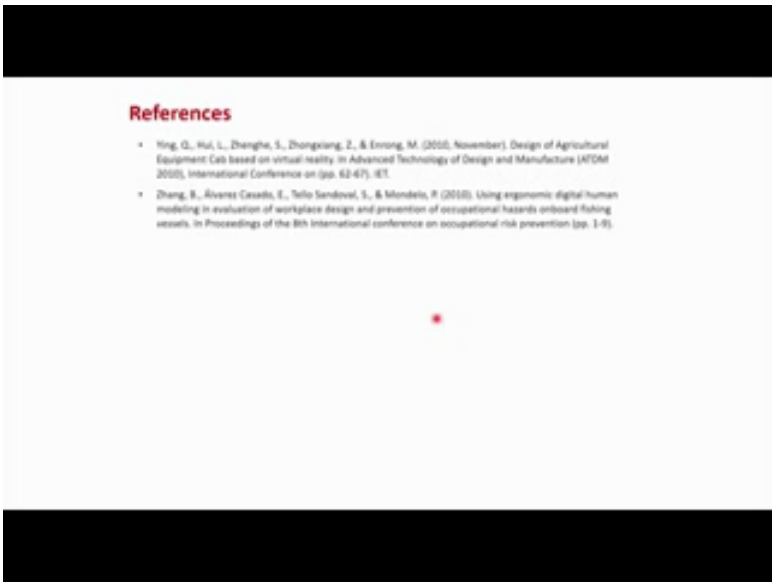


So, I suggest all the students as I also suggest in earlier modules that these are only few research papers which I have collected. So, you can go through more research papers in the particular domain to get more idea about application of digital modeling software in that particular operation sectors so.

Thank you.