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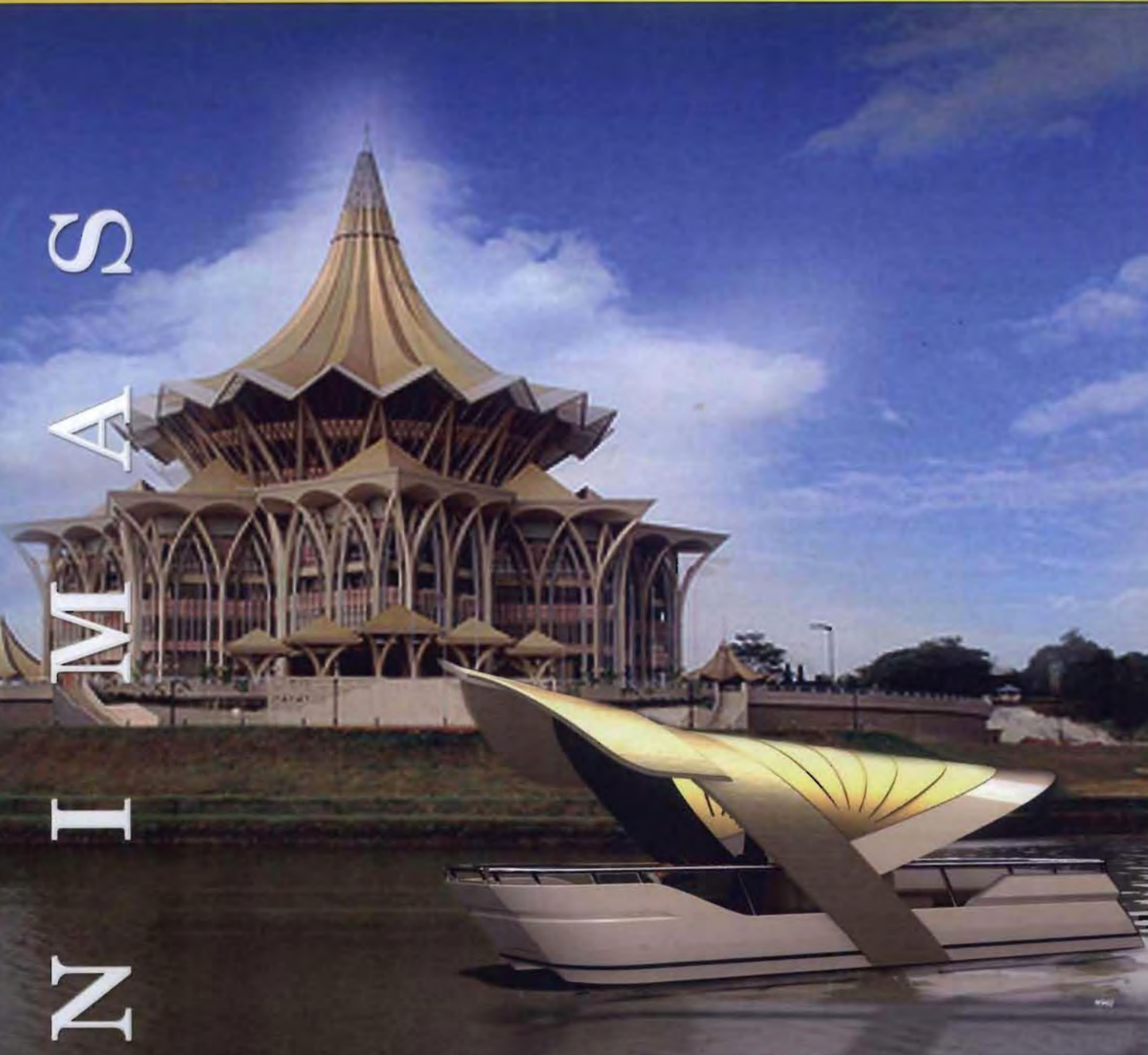
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Niche Area:
Industrial Design

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FOREWORD



It is with great pleasure that I warmly welcome you to our latest issue of our Research Update for the year 2013. In this issue, which is themed “Industrial Design”, we showcase one of UNIMAS’ niche areas with the objective to promulgate ideas from creative and innovative solutions for commercialisation. Industrial design harmonises the art, science and technology whereby the aesthetics and usability of a product can be improved for marketability and production. Industrial design has the capabilities to augment a product beyond the manufacturing process through application of innovative and creative design solutions. Researchers execute design solution towards problems of form, ergonomics, product usability, marketing, brand development and sales. In essence, it encompasses a wide range of user and technology driven products such as furniture, household items, toys, transportation, electronic and electrical products, which are important for a sustainable economic development of the country.

In tandem with the objectives of UNIMAS, faculties and institutes, such as, the Institute of Design and Innovation (INDI), and the Faculty of Applied and Creative Arts (FACA) aspire to provide a supportive environment for the invention and generation of creative ideas through design and innovation. This provides a platform for the university’s multidisciplinary experts to embark on or consolidate their research in design and innovation to transform ideas into highly innovative and marketable products with strong potential for commercialisation. Currently, industrial design in UNIMAS, is emphasising on sustainable development and sourcing for indigenous knowledge and experience through the understanding of indigenous design artifact invention, local material resources, and cultural diversification, specifically in Borneo. This provides the impetus to explore a goldmine of opportunities in design and innovation practices towards discovering new approaches and meaningful solutions for human needs.

Advancement in research and development at UNIMAS would certainly be a trajectory in the frontier of knowledge. With that in mind, this issue highlights outstanding research in design and innovation that have won awards at local and international levels, such as at the British Innovation Show (BIS), Innova Brussels, Belgium, and the Seoul International Invention Fair (SIIF), South Korea, just to name a few. The research and development products may have great potential to be commercialised by local and foreign industries.

I am optimistic that with the emergence of Industrial Design today, and the tireless efforts from our researchers will serve as a catalyst for enhancing our economic, social, cultural and environmental quality of life in Malaysia and ultimately, in the world.

Thank you.

A handwritten signature in black ink that reads "Peter Songan". The signature is fluid and cursive.

Prof Dr Peter Songan
Deputy Vice Chancellor (Research & Innovation)
Universiti Malaysia Sarawak

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SAFETY AND ERGONOMICS OF A RIVER TAXI DESIGN AT WATER FRONT, KUCHING

*Researcher: Saiful Bahari Mohd Yusoff
Faculty of Applied and Creative Arts, Universiti Malaysia Sarawak*



Design evolution of the River Taxi (*Penambang*).



Design revolution with strong local character.



Design revolution inspired by "*Daun Simpuh*".

One of the most popular means of water transportation in Sarawak is the *Perahu Tambang* or more popularly called *Penambang* among the locals. It is used daily by those living along the Waterfront Kuching; to cross the river or transport their goods. Demand for the *Penambang* is on the rise as it is found to be economical and a fast mode of transportation across the river. *Penambang* is also popular with the tourists as it is unique and has its traditional values. Since the introduction of the *Penambang* and till today, there have been no systematic modifications carried out on the design and safety aspects of this river taxi. A survey conducted among the users and tourists have indicated their concern for safety. For example, although no accidents have occurred to date, the present river taxi, particularly the traditional boat, is narrow, fully covered and windowless and it induces a feeling of insecurity. The lack of life jackets also increases the concern of safety. In order to ensure that the traditional river taxi remains as a means of public river transport among the local and as a tourist attraction, the function and usage of the river taxi therefore need to be upgraded. It will not only increase the boat operator's earnings, but also help to increase the popularity of this service in the state. As such the design of the proposed river taxi has to be good, interesting and safe. In addition, this study also aims to popularise water transportation in Malaysia. Therefore, the designer has applied both evolution and revolution approaches to existing river taxi design at the Kuching waterfront, concentrating on the safety and ergonomics of the river taxi. It is hoped that with the new design of the river taxi, the confidence level of the river taxi operators to compete with modern boat services available at Kuching Waterfront is increased.

This research is supported by Universiti Malaysia Sarawak Short Term Grant 242/01(01).

DESIGN OPTIMISATION OF A SEARCH AND RESCUE MICRO-SUBMARINE

Researchers: Muhammad Firdaus Abong Abdullah¹, Mastika Lamat¹, Abdul Reizal Dim¹ and Andrew Ragai Henry Rigit²

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²*Faculty of Engineering, Universiti Malaysia Sarawak*

A micro-submarine (micro-sub) is a small unmanned submarine, which is normally deployed for various dangerous underwater tasks including search and rescue. The micro-sub is very useful in executing and completing dangerous tasks effectively with minimum costs and risks. The design of the micro-sub must be optimised in every aspect of its practicability and operation ability. A combination of industrial design and engineering method is used to create the micro-sub from design concepts up to workable prototype. The application of industrial design aspects that optimises the operator's ergonomics, configuration of sensitive electronics and software unit compartments and the development of the body shell streamline. Ergonomics or human factor aspects is applied in the design of the micro-sub remote control and picture screen unit with emphasis on minimising the operator's fatigue during actual search and rescue operation which can take hours and even days. The correct configuration of sensitive electronics and software unit compartment is vital to provide easy access to maintenance and repair, and also to prevent water leakage into the compartments. Industrial design application starts with design concepts based on the operational requirements of the micro-sub. The final concept is translated into computer aided design software, Autodesk 3D Max and CATIA to generate a 3D model of the micro-sub. Modifications of the model are done virtually. The computer generated model data are then fed to rapid modelling software, 3D Printer to produce a full-scale rapid prototyping model. In order to obtain a smoother velocity profile, better stability and control of the micro-sub, engineering technique is applied such as the flow visualisation which is vital for determining the effects of fluid flow conditions around the micro-sub when it is submerged in water during typical search and rescue operation. The 3D model data are also used to create a computer simulation of the micro-sub in actual underwater environment using a commercially available computational fluid dynamic (CFD) package, Star-CD as shown in Figure 1. The effects of the micro-sub geometry on the velocity and pressure distributions on the micro-sub outer shell surface were tested and analysed for $Re= 500,000$ and $3,000,000$. The analysis output is used to propose further enhancement of the micro-sub with a smoother velocity profile around the body shell. The final design is custom fabrication for field trials and evaluations.

Award: Gold Award, Malaysia Technology Expo 2008.

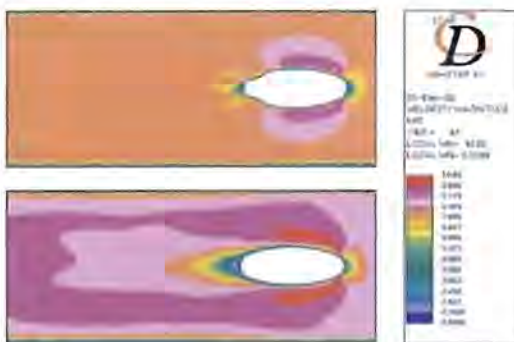


Figure 1: Result of the simulation showing the velocity profiles for laminar flow at $Re=500,000$ for first model (top) and second model (bottom) during testing using the CFD package.



Figure 2: Front and rear view of the final workable prototype of the micro-submarine.

“POPAPLANT” : BIODEGRADABLE PLANTER PACKAGING

*Researchers: Musdi Shanat, Norhayati Suleiman, Maizatul Nurulhuda Saadon and Noorhaslina Senin
Faculty of Applied and Creative Arts, Universiti Malaysia Sarawak*

“POPAPLANT” is an excellent and eco-design planter packaging developed by a group of researchers from the Department of Design Technology, Faculty of Applied and Creative Arts. It was inspired from the concepts of origami and envelope. “POPAPLANT” serves as a packaging that assists the stages of the plant, and later transforms itself into a germinator. The biodegradable planter consists of soil and a specific type of plant seeds which provide an option to consumers to choose the type of plant they want to grow as shown in Figure 1. When the plant grows larger, it can be transferred to the backyard without taking out the planter. Conventional pots available in the market are made from plastic and ceramic. In addition, the plant has to be transferred from the pot to the ground. However, for the biodegradable collapsible planter, consumers only need to dig a hole in the ground and the “POPAPLANT” will gradually dissolve into the ground. “POPAPLANT” biodegradable planter is a unique pot made from a thin layer of “biodegradable bio-plastic material plastic” and “breathable geo-textile” in which it allows permeability when used in association with soil as illustrated in Figure 2. These combinations give consumers an innovative planter pot that can be proudly showcased in their garden for many years. This planter packaging is a good substitute for nursing plants instead of using the plastic bags and it is also perfect to be displayed on personal workstation and kitchen for decorative purposes as presented in Figure 3. “POPAPLANT” planter packaging distinguishes itself from the other competitors in the market because of its design, colour, shape and material. It is also easy to open the packaging and the product is easy to use.

Award: Bronze Award, UNIMAS R&D Exposition, 2013.



Figure 1: A final design of “POPAPLANT” biodegradable planter packaging.



Figure 2: Sample of materials used for biodegradable planter packaging.



Figure 3: Design exploration for “POPAPLANT” biodegradable planter packaging.

MOBILE AUTOMATED WHITE PEPPER RETTING MACHINE INTEGRATED WITH CRUDE ENZYMATIC SOLUTIONS

Researchers: Cathy Ambrose¹, Mohd Danial Ibrahim¹, Azham Zulkharnain² and Muhd Fadzli Ashari¹

¹Faculty of Engineering, Universiti Malaysia Sarawak

²Faculty of Resource Science and Technology, Universiti Malaysia Sarawak



(a) Main body (b) Blade (c) Inner cylinder (d) Side cover (e) Shaft, pulleys, gears (f) Assembled figure of retting machine.

In Sarawak, pepper is grown extensively in some rural areas and about 70 percent of Sarawak's pepper is exported as whole black pepper and the remaining as white pepper. Traditionally, the production of white pepper is complicated and takes a lot of effort and time, thus yielding lower production compared to black pepper. The method to produce white pepper is called pepper retting. It involves removing the outer skin of the matured pepper berries. The berries are kept under running water for seven to nine days to soften its skin. Then, it is stepped on with human feet to scrub off the skin. The left behind white berries are then washed out and dried. This process is time consuming. Therefore, there is a need to design a machine that can produce white pepper more efficiently. This invention provides a new integrated mechanical way to produce white pepper by using enzymes. It uses friction force generated between the blade and inner wall of the skin of the berries. The enzymatic solution accelerates the production process, and is suitable for efficient mass production of high quality cottage industries white pepper.

This research is supported by Ministry of Higher Education Malaysia research grant: RAGS/E14099-F02-69-937/2012(36).

DESIGNING ACTUATOR ARMS FOR ECO-HDDs

*Researchers: Chew Chang Kit, Mohd Danial Ibrahim, Amir Azam Khan and Ervina Junaidi
Faculty of Engineering, Universiti Malaysia Sarawak*

The growth of technology advancement is tremendous, the same goes to the requirement for the improvements of Hard Disc Drives (HDDs). HDDs manufacturers and IT industries are always looking for an alternative way to increase the storage density and data transfer rate of HDDs. High speed disk rotation is also a requirement for faster rate of data transfers. However, the increase of these disk rotational speeds causes high-speed airflow in the drive compartment which affects the head positioning accuracy and power consumption. A higher rotational speed easily induces disk flutters and vibrations of the head actuator arms and suspensions. Moreover, the power consumption loss also increases due to the increase of air friction or wind age loss. Therefore, changes of the static and dynamic characteristic of HDDs are vital to overcome these problems. In our previous research, it is proven that a bigger window in actuator arm provides better heat dissipation. Simultaneously, an S-shaped actuator arm (IP submitted) was also numerically designed and tested using commercialised flow simulation software. The results show that the new design allows a better air-flow inside the HDDs compartment compared to the conventional designs. Continuous efforts have been made in the following years by comparing the previous design (S-shaped) with the new design (U-shaped) and the conventional ones. Rotational flow simulation was used in order to obtain better accuracy of results and gives a clearer face of comparison. Different rotational speeds of 5,400 rpm, 7,200 rpm, 15,000 rpm and 20,000 rpm were also investigated in this research to further examine the suitability of rotational speed for the designs. This research gives promising results of a new generation of higher performance HDDs which are mainly used in gigantic servers nowadays.

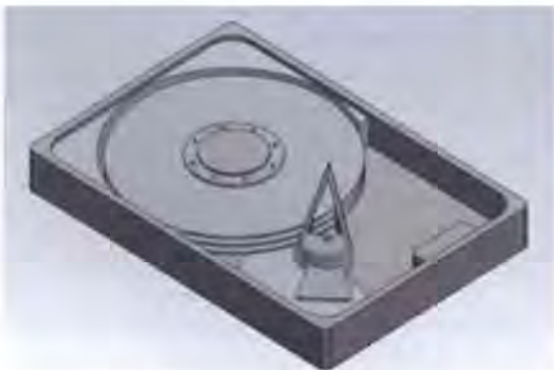
This research is supported by Ministry of Higher Education Malaysia research grant: RAGS/E14099-F02-69-937/2012(38).



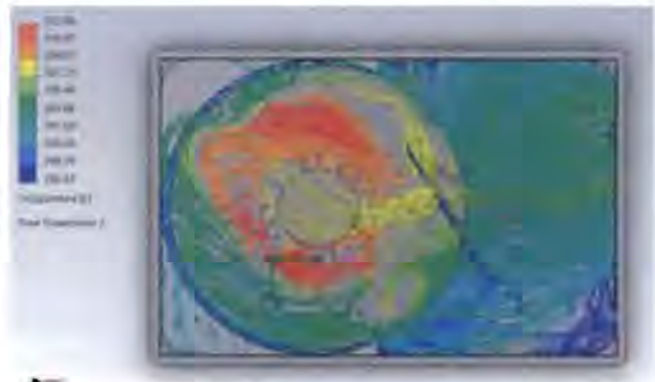
Actuator arm in HDDs.



S-shaped actuator arm design.



HDD body compartment design.



20,000rpm (temperature, S-shaped).

IMPROVING MICRO-NEEDLE DESIGN

*Researchers: Siti Noor Haizum Semait and Mohd Danial Ibrahim
Faculty of Engineering, Universiti Malaysia Sarawak*



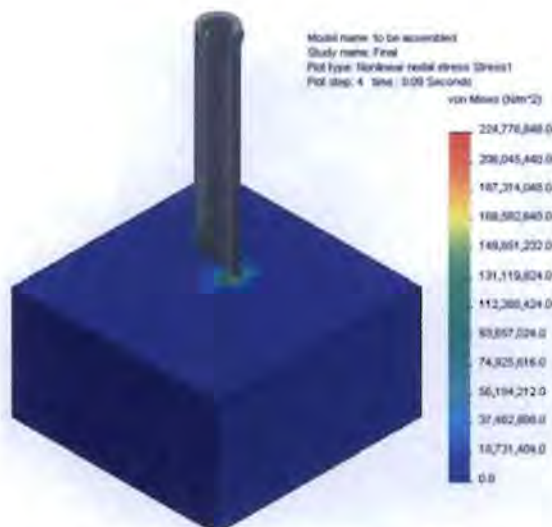
Mosquito blood sucking close-up.



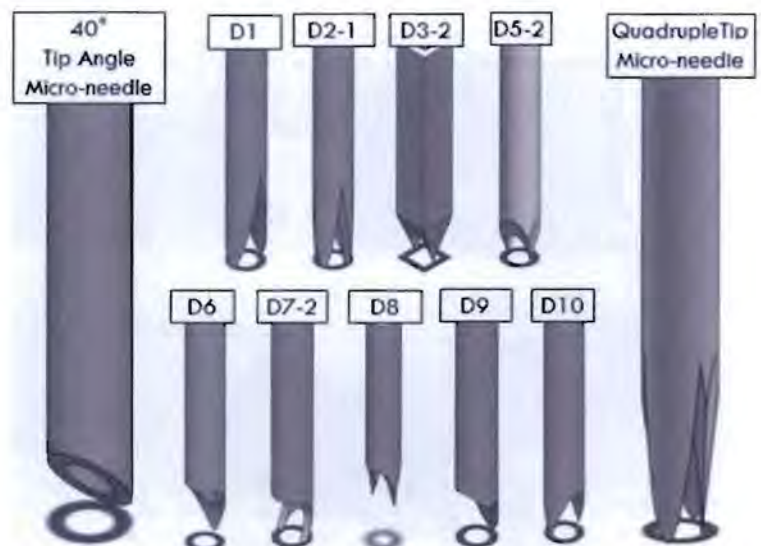
Mosquito's fascicle tip zoomed to 50um.



Conventional syringe.



Simulation test of micro-needle designs onto human skin.



Micro-needle designs.

By imitating mosquito's fascicle tip, a painless and safer alternative to hypodermic needles is numerically designed and tested. Hollow micro-needles were designed with the dimension of a 300 μm outer-diameter and 180 μm inner-diameter with 2 mm in height with different tip angles and shapes. The micro needle is commonly used for drug delivery and blood withdrawal. This research aims at measuring and minimising the maximum stress applied onto the skin during medical penetrations. The material used is Titanium 6Al4V. The normal ranges of the tip of the micro needle are from 39° to 56°. The tip angle of 40° is taken as reference from the averaged value of the normal tip angle to design micro-needles. This QuadrupleTip Micro-needle is numerically proven that it is painless compared to hypodermic needles used in common medical applications. The three-dimensional geometry successfully improved the insertion performance and creates potential for a novel painless blood withdrawal mechanism. Target users are the Ministry of Health, hospitals, drug industries, bio-engineering related industries and diabetic patients who require insulin injections daily.

NON-NEWTONIAN AND NEWTONIAN FLOW CHARACTERISTICS OF A MODIFIED SPIRAL THRUST BEARING

Researchers: Melissa Elimy Mulen¹, Mohd Danial Ibrahim¹ and Yuta Sunami²

¹Faculty of Engineering, Universiti Malaysia Sarawak

²Faculty of Engineering, Tokai University, Japan

The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. This bearing is aimed at improving its driving mechanism. The project objectives are to determine the relationships among rotational speed, bearing surface and flow of field when the rotational speed is varied. The bearing is designed using a mathematical approach of geometry optimisation by maximising its dynamic stiffness. The design processes of obtaining the modified spiral designs were conducted by changing the allowable film thickness, which corresponds to the tolerance of the bearings as illustrated in Figure 1. The bearing designs are then reconstructed using AutoCAD and then simulated using a commercial software Comsol Multiphysics. In the simulation process, the pressure, velocity and temperature distribution that greatly affect the bearing performance and surface are investigated using three types of mediums, which are oil, water and air as shown in Figure 2. With this design, there is a high possibility of drastically improving the performance of the bearing in industrial and precision machineries applications.



Figure 1: Modified spiral bearing.

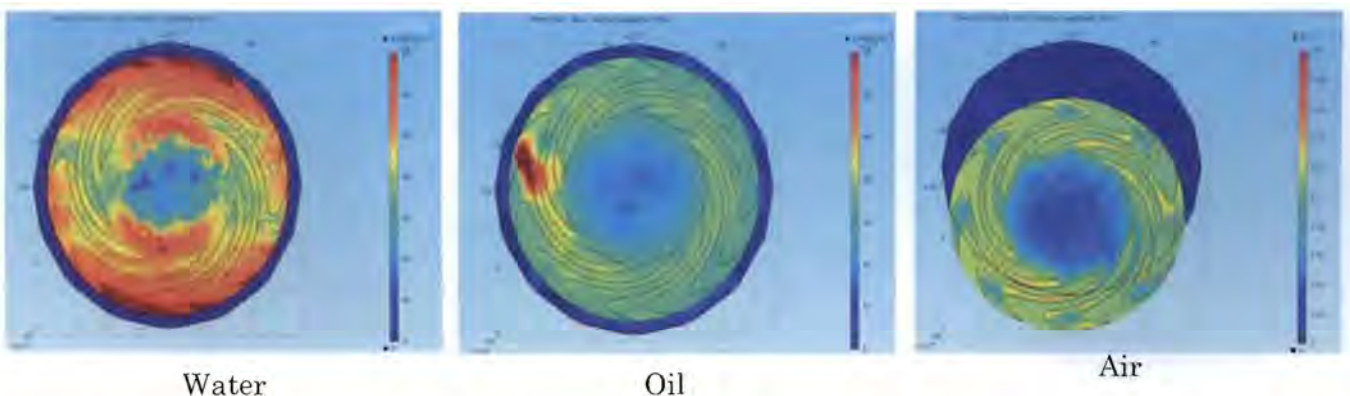


Figure 2: Velocity distributions for water, oil and air as lubricants for 7,200 rpm speed.

MACRO-DIMPLED AND MACRO-RIVETED AIRPLANE WINGLETS

Researchers: Zaharah Ibrahim, Mohd Danial Ibrahim, Mohd Shahril Osman and Amir Azam Khan

Faculty of Engineering, Universiti Malaysia Sarawak

Winglet is a wing supplementary device used to improve airplane aerodynamic properties for lesser fuel consumption. In this research, dimples and rivets are surface modification applied onto the winglets for better performance compared to the ones with smooth surfaces. Macro-dimples and macro-rivets shown in Figure 1, refer to protuberances or surface irregularities made out of dimples and rivets with the size of approximately 2.0 cm~5.0 cm. Numerical simulations were conducted using a commercial engineering software. The cruising speed for commercial airline is 900 km/h. However for this simulation, all of the parameters were scaled using Reynolds number which coincides with the model sizes. The simulation shows that macro-riveted winglet gave better performance with an increase of 3% in speed as compared to the smooth winglet (control) (Figure 2). Thus, it is the faster of the two designs. The results also show that the macro-riveted winglet has less drag and better lift compared to the macro-dimpled winglet. The graph shown in Figure 3 shows the results comparing the three winglet designs. Future research is necessary to investigate the effects of different altitude and angle of attacks on these winglets.

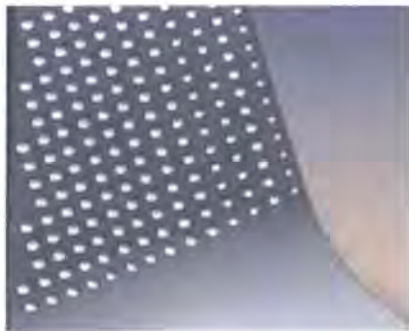


Figure 1: (a) Macro-Dimpled Winglet



(b) Macro-Riveted Winglet.



Figure 2: Velocity simulation on Macro riveted winglet.

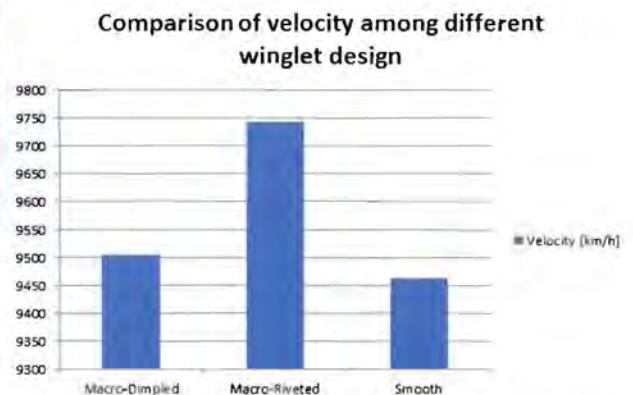


Figure 3: Comparison of velocity among different winglet designs.

AN APPLICATION OF SEMANTIC DIFFERENTIAL APPROACH TO EVALUATE DESIGNER AND USER GROUP PERCEPTION ON AESTHETICS, FORM AND UTILITY THROUGH THE MEDIUM OF CHAIR DESIGN

Researcher: Musdi Shanat

Faculty of Applied and Creative Arts, Universiti Malaysia Sarawak

The main objectives of this research are to explore and analyse the semantic differential techniques in measuring and evaluating Designer and User Group perceptions through the medium of chair design. Their behavioural, cognitive and affective reactions to furniture design are able to supply valuable information to designers in seeking consumer perceptions, which include the quality and expectation they wish to find in it. The implication of differences and similarity in preferences and relationship between literal design elements and image words form the ground work for design specifications, and lead to a better understanding of consumer taste and preferences. There are three interactive research phases that were rigorously applied in this study, and semantic differential questionnaires were employed as a tool to access participants' perceptions. It is important to highlight that the researcher did not only work on the survey and analysis per se, but it was also important to design and build prototypes based on the results and recommendations. The first research phase comprises the establishment of design brief and concept. Once this step was completed, the researcher began to construct a prototype (Sample 1) and concurrently the semantic differential questionnaire was formulated. The simultaneous actions of circulating questionnaires and exhibiting the prototype are crucial for the respondents to gain confidence and understanding when reading the questions. This technique also helped to produce accurate feedback for the next stage in design development. The second phase of research involves the redesign and re-briefing of the first prototype. A redesigned chair (Sample 2) not only projected and followed these commendations and preferences from the questionnaire but also reflected the respondents' tastes and needs. Improvements to the questionnaire were carried out. Finally, the third research phase is a full circle of designing and constructing a new chair (Sample 3). This research not only demonstrates the three sets of sample attributes related to form, aesthetics and utility themes but allows the data to be organised in classes of "values" which describe the characteristics of the chairs. In addition, this approach provides presentation of particular data and allows for or shows the disparity of how the chairs were perceived by the participant groups. In summary, the responses of Designer and User Groups participants reflected "individual taste" and dissimilarity in judging the physical appearance of a chair. The User Group ranking clearly differentiates each chair, whereas the Design Group has one clear preference, and an equally rated group of "also rams" possibly reflects the more highly trained "eye" of the professional group, who may be expected to exert a more rigorous actual appraisal than the User Group. The User Group's results reflect a broad set of opinions, likes and dislikes, and represents the commercial "common value" for product design. The feedback obtained also adequately represents a direct communication of the actual consumers, and potentially offers a new brighter prospect for furniture design development that is closely linked to consumer desires. The intervention of the semantic differential approach in the product design development process can take account of the client's preferences, rather than only designing a product based on the designer's concept and personalised idea alone.



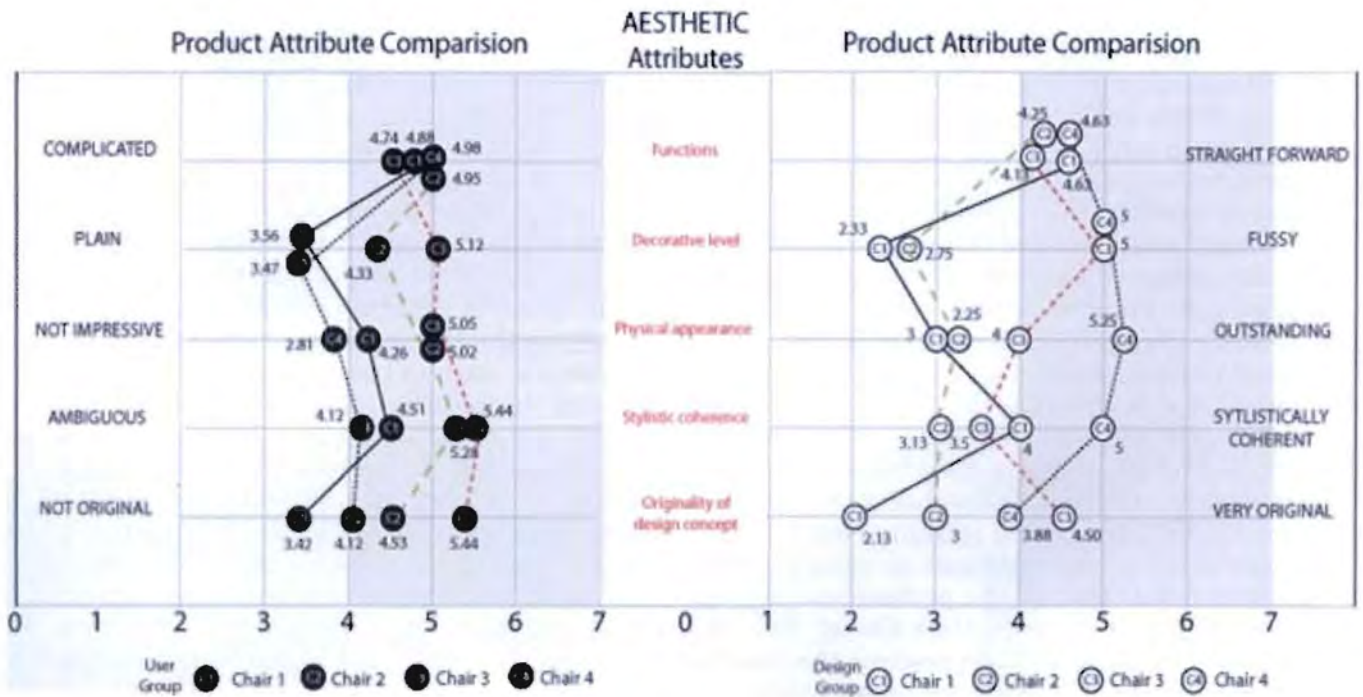
Sample 1



Sample 2



Sample 3



Aesthetics scores for chair designs, designer and user group.

FIRE RETARDANT SOUND ABSORBER PANEL (SAP®) FROM SAGO WASTE

Researchers: Zainab Ngaini, Khairul Aidil Azlin Abd Rahman, Norhaizat Sundin, Teng Jingxin and Vanessa Lawai

Institute of Design and Innovation, Universiti Malaysia Sarawak

Sago palm is commonly found in tropical lowland forests and freshwater swamps. It is one of the main exports of Sarawak. Sarawak is currently the world's largest exporter of sago products, exporting annually about 25,000 – 40,000 tonnes of sago products to various countries such as Singapore, Taiwan and Japan. The mass production of sago produces residues during processing. Approximately seven tonnes of sago pith waste is produced daily from a single sago starch processing mill. The residues are discharged into the river which would eventually contribute to serious environmental problems. Accumulation of sago waste in solid form has resulted in an increased environmental concern. In view of utilising agricultural waste material for developing sustainable construction materials, phosphazene-incorporated sago wastes as pendant groups have been prepared and structurally characterised. The incorporation of phosphazenes as pendant groups to the backbone of sago matrix afforded a class of organic-inorganic materials that exhibited useful thermal properties such as flame retardancy and self-extinguishability. The chemically modified sago wastes composite is applied with binders and developed as fire retardant sound absorbing panels (SAP®). SAP® is a class of organic-inorganic based materials that exhibit excellent fire retardant properties. In comparison, the panel of untreated sago waste is easily ignited and burned to completion into ashes (Figure 1a), whereas the ignition test onto SAP®, even after soaked with kerosene, is resistant to burning and readily self-extinguished when the kerosene is consumed (Figure 1b). The force ignition onto SAP® without kerosene only resulted in formation of chars at the targeted area.



Figure 1: Flame ignition test of (a) Untreated Sago Waste (b) SAP®.

SAP® is designed for simple installation to the wall. Aluminium or wooden frame is used as a holder for the panels to be arranged accordingly (Figure 2a-b) based on the customers' preferences. SAP® is also designed with an interchangeable casing made of thermosetting plastic with various modern and contemporary patterns that suits the customers' preferences (Figure 2c-d). The casing also functions as a double layer silencer and sound filter. The installation method of the finished product with plastic wall casing is shown in Figure 2(a-d).

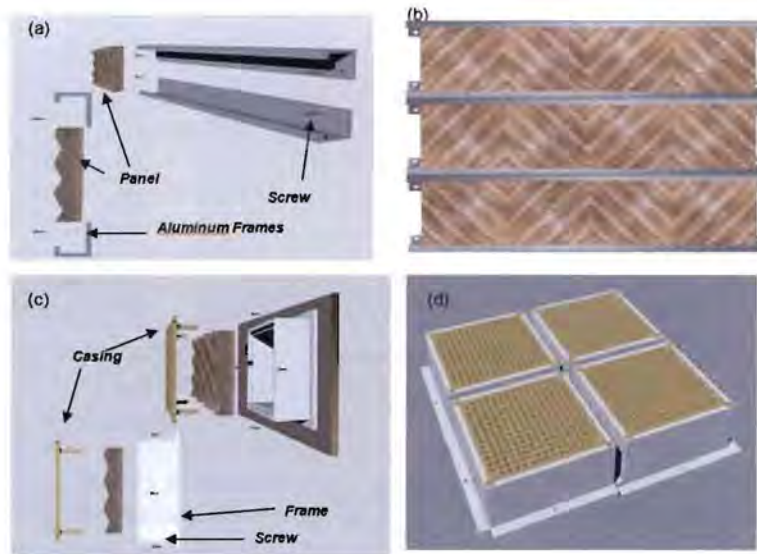


Figure 2(a-d): Mounting and installation of SAP®.

This research is supported by Ministry of Science, Technology and Innovation (MOSTI) grant Dana Inovasi DI/02/2007(02) and FRGS/01(03)/608/2006(41) respectively.

ECOMOD: UTILISING SAGO EFFLUENT AND BIOMASS AS MORDANT FOR NATURAL DYEING AND PRINTING

*Researchers: Nazlina Shaari, Khairul Aidil Azlin Abd Rahman and Zainab Ngaini
Institute of Design and Innovation, Universiti Malaysia Sarawak*

Sustainability of the textile dyeing industry hinges on the ability of the industry to meet today's challenges related to the environment and human health. The dye stuff industries are suffering from the high cost of feedstock and energy for dye synthesis. In this research, an alternative method of using sago effluent in natural dyeing process is applied. Natural dyes are considered sustainable and eco-friendly. The products of natural dyes are very much in demand due to their eco-friendly nature and ability to produce different shades. However, most of the natural dyes have been treated with some chemical mordants in order to fix the dyes onto the fabrics. During the pre-mordanting and simultaneous mordanting processes of dyeing using natural dyes, many heavy metal additives such as copper, iron, aluminium and ammonium sulphate are used to improve the take-up quality of the dyes onto the fabric as well as the colour and light-fastness. As far as environmental issue is concerned, the alternative method involves developing sago effluent formula and waste into pulverised form and adding it with natural pigment from plants. This combination enables the user to mix the formula easily to create a dyebath or a printing paste. The new usage of sago effluent as a mordant for natural dyes is able to reduce chemical and water usage. In this method, the pyrolysis process involved leaves mostly carbon as a residue. Utilising 100 percent of sago residue ash in the natural dyeing process does not only produce beautiful colour tones of natural colours in fabrics, but also promotes green environment to the textile industries because the natural dyes from sago effluent are also non-toxic and biodegradable. This research has also successfully discovered the functions of heterogeneous catalysts as additives to change the stinking odour to a pleasing smell. This low technology process will create huge impact to the textile industry in terms of costs as well as environmental friendliness.

This research is supported by Ministry of Higher Education Malaysia research grant: PRGS/1/11/SSI/UNIMAS/02/02.

Awards:

- (i) The Very Best Award, Malaysia Technology Expo 2012*
- (ii) Gold Award, Malaysia Technology Expo 2012*
- (iii) Gold Award, Seoul International Invention Fair 2011*
- (iv) Bronze Award, International Exposition of Research and Invention of Institutions of Higher Learning (PECIPTA 2011)*
- (v) Double Gold Award (Potential for Commercialization), British Invention Show 2012*
- (vi) Gold Award (Consumer Product Category), British Invention Show 2012.*



EcoMOD Biomass.

EcoMOD from sago effluent.

BioCHAR DRAWING MEDIA

*Researchers: Nazlina Shaari, Zainab Ngaini, Khairul Aidil Azlin Abd Rahman and Norshada Abd Latif
Institute of Design and Innovation, Universiti Malaysia Sarawak*



Figure 1: BioCHAR.

Charcoal stick is very popular amongst the fine artists as a drawing medium. However, these drawing media are quite expensive due to the materials used which are mainly willow and vine wood. In this research, sago biomass is developed from char using hot compressed method to produce an alternative charcoal stick. This method produced fine quality charcoal stick that is suitable for drawing. The new charcoal stick is made from 100 percent sago waste char as shown in Figure 1. It is a low technology process and has good potential for commercialisation. This product is targeted for local and international art suppliers and designers. It is cheaper than the commercial drawing charcoal sticks that are made from wood.

This research is supported by Ministry of Higher Education Malaysia research grant: PRGS/1/11/SSI/UNIMAS/02/02.

SOLUBLE-POWDERED NATURAL DYES FROM SARAWAK FOR TEXTILE DYEING

Researchers: June Ngo Siok Kheng¹, Ong Wan Fen¹, Fasihuddin Badruddin Ahmad² and Kopli Bujang²

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The number of Iban weavers who have the knowledge of mixing dye solutions has decreased over the years because the process of dyeing is tedious and labourious. For example, the searching for the dye yielding plants in the jungle and the preparation and dyeing processes can take more than a day or up to a week. This study focuses on the production of soluble-powdered natural dye extracts obtained from *Sebangki* bark (*Neesia* spp., Bomb.; *Tristaniopsis* spp., Myrt.), *Engkerabai Paya* leaf (*Psychotria viridiflora* Zoll. ex. Miq.) and *Engkudu* root (*Morinda citrifolia* L.). These three natural colourants (as shown in Figures 1, 2 and 3) are typically used by the native Iban community in Sarawak to dye silk and cotton threads for Pua Kumbu weaving. The purpose of this study is to convert the plant extracts into soluble powdered form to dye silk fabrics. The use of distilled water and ethanol as solvents to extract natural dyes from *Neesia* spp. bark, *M. citrifolia* root, and *P. viridiflora* leaves and the use of freeze-drying to convert liquid dye extracts to soluble powder were successfully carried out in this research. Dyeing silk using the powdered natural dye extracts from *Neesia* spp. bark, *M. citrifolia* root, and *P. viridiflora* leaves with alum and lime as mordants (for both pre-mordanting and simultaneous mordanting) were also successfully carried out when different shades of browns and reds were produced. For the colourfastness test, the *M. citrifolia* root is the most successful compared to the other two types of plants, with a greyscale rating between 4/5 and 5. As for the rubbing colourfastness and light-fastness, alum is the best mordant for all three plant types. In addition, dyeing using the soluble-powdered dyes from these three plants is easy and straightforward as it does not involve tedious preparation, as compared to the many dyeing hours spent by the native Iban weavers.

This research was supported by the Universiti Malaysia Sarawak research grant: DI/08/2008-04.



Figure 1: *Sebangki* (*Neesia* spp., Bomb.; *Tristaniopsis* spp., Myrt.) bark.



Figure 2: *Engkerabai Paya* (*Psychotria viridiflora* Zoll. ex. Miq.) leaves.



Figure 3. *Engkudu* (*Morinda citrifolia* L.) roots.

AVATAR CONTROL SYSTEM FOR LIVE PERFORMANCE ANIMATION

Researchers: *Khairul Aidil Azlin Abd Rahman¹, Azwan Abidin², Ng Giap Weng³, Loh Ngik Hoon¹, Vanden Michael² and Kenny Hui²*

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3D model of character design.



Facial emotion using game pad.



Interactive gallery.

The Malaysian government has included creative industries as one of the 12 National Key Economic Areas (NKEAs) for the country to become a high-income nation. The global animation market was estimated to grow at 16.5 percent to US\$79.7 billion (RM259 billion) this year from US\$68.4 billion in 2008. However, the animation market in Malaysia was merely US\$50 million. Avatar is an animated object that can be manipulated and the manipulated image appears immediately on a computer screen. It is an icon or animation to represent a participant used in internet chat and games. Digital puppetry is an innovation of interactive application derived from the concept of traditional puppetry known as wayang kulit. In order to imitate human movement, a virtual robot application is introduced to control the robot's movement through sensor points. However, this method is too complicated and expensive as it involves installing hardware on site during performance. The estimated cost for installing the hardware and software ranges from USD\$10,000 up to more than USD\$100,000. This makes digital puppetry available only for high profile events such as television broadcasts and films. In order to solve the problem, this research has developed a facial expression control system for digital puppetry using the integrated software and computer programming such as Autodesk Maya, Autodesk Motion Builder, Craft Director Studio, Papervision3D, ActionScript 3.0, and GlovePIE. The avatar animation is created using a 3D-character that can be manipulated at real-time animated virtual puppet. It involves a "performer" directing the animated object or character movements and voice synchronisation. This is also known as performance animation. The system utilises inexpensive devices and is suitable for a wider range of people and companies such as TV broadcast, movies, drama. Furthermore, for commercialisation impact, through this new development of avatar control system, the animation process will be shorter and cheaper. Thus, this will benefit the animation industry. The end product of the avatar model can be downloaded by mass consumers through online purchasing through computer or smartphone application (apps) and also for entertainment, education, tutoring and others purposes.

This research is supported by Ministry of Higher Education Malaysia research grant: PRGS/1/12/SSI08/UNIMAS/01/01.

COMPACT RESCUE STRETCHER

*Researcher: Khairul Aidil Azlin Abd Rahman
Institute of Design and Innovation, Universiti Malaysia Sarawak*



Figure 1: Using a single pole to carry the patient.



Figure 2: Patient is transferred from mobile stretcher to the bed.



Figure 3: Attached blanket to cover the patient.



Figure 4: Compact packaging of the stretcher.

When environmental disasters such as earthquake, tsunami, flash floods and typhoons strike, rescuers and affected communities face many problems during evacuation; before, during and after the disaster. In this research, an emergency foldable stretcher is made from canvas with a fire retardant layer for use during emergency response, disaster situations, camping, hunting and outdoor activities. The main objective of this product is for use during emergency evacuation for injured people. The weight of this stretcher is approximately 2 kg which weighs 60% less than a conventional stretcher. This product bears a maximum of 220 kg load. In order to reduce the burden of weight, this product is designed to be carried by two or four people. During emergency, this stretcher does not require any particular assembly or preparatory operation. If necessary, the rescuers may use props that are readily available in the house such as broom or mop sticks. The props can be attached at the handle of the stretcher. Graphical illustrations explaining the instructions on how to set up the stretcher printed with "Glow in the dark" pigment are clearly displayed on the stretcher. This design comes attached with a blanket to cover the patient and to ensure safety during transportation. The blanket can also be used to support and immobilise bone structure. However, this stretcher is not suitable for neck and back spine injuries. A small first aid kit is fitted at the compartments of the stretcher. When there is fire in the building, the stretcher can be used to carry the patient and used as resting mat at the evacuation centre. In addition, this stretcher is also suitable for down loading patient using staircase where lift facility is not available in high storey building. Furthermore, the product comes in a folded compact package that is very convenient to carry and easily stored in ambulance, car or at home. The potential market includes families living in flats, apartments and condominiums, government and private owners of offices in high storey building, housing developers, construction site, insurance companies, Ministry of Health, Ministry of Defence, Red Cross/Red Crescent, United Nation Relief NGOs and individuals who are concern about safety.

Intellectual Property: MY- 09-00538-0101.

Awards:

- (i) *Bronze Award, PERCIPTA 2007*
- (ii) *Silver Award, Malaysia Technology Expo, MTE 2009*
- (iii) *Bronze Award, Seoul International Innovation Fair SIIF 2011, Korea.*
- (iv) *Gold Award, British Invention Show, BIS 2012, London, UK*

TRANSFORMABLE BENCH

Researchers: Khairul Aidil Azlin Abd Rahman¹ and Md Nur Syaikhul Al Hafiz Salleh²

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This research aims to investigate the usage of dual-function furniture which meets the needs of consumers and can fit into a small area such as flats with limited space. This investigation has identified the weaknesses in existing designs which include the chair structure, functions, rigidity, storage structure, ergonomics, packaging, mobility, finishes, material application and local identity. Through design analysis, the dual-function outdoor furniture is created. The advantage of the dual-function furniture design is that the two-seater wooden bench that can easily be converted into a four-seater bench and a table with a simple pulled-up extension. The transformable bench is made from tropical wood with dark brown finished stain and beautiful minimal ornaments are engraved on the wood using laser cutter to show an authentic Malaysian style product with a smart solution. An optional accessory such as big umbrella creates a cosy look and it is also for outdoor usage. The design is created in geometrical form for easy production, finishing, compact packaging and DIY assembly at a low production cost.

Intellectual Property: MY 09-00537-0101.

Award: Silver Award, PERCIPTA 2009.



Two-seater bench transformed into a four-seater bench and table.

APPLICATION OF BAMBOO BIO-COMPOSITE (BB-PP) FOR CAR INTERIOR ACCESSORIES

Researchers: Fandi Ahmad Syah Amir Syah¹, Khairul Aidil Azlin Abd Rahman²,
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Bamboo is an important environmental friendly material. Bamboo grows and matures faster than any other type of wood. This study emphasises the application of bamboo as a material for car accessories. The composite materials are made from bamboo particles mixed with plastic matrix material to produce car accessories. This composite material is formed by using the moulding process using pressure produced by a twin-screw extruder machine. The average tensile strength for the bamboo bio-composites polypropylene (BB-PP) using the extrusion process is approximately 20.4 Mpa. This study also shows that the average flexural strength (Modulus of Rapture, MOR) to BB-PP in the same fillers 70/28/2 is 39.7 Mpa. The result of Izod impact revealed BB-PP recorded an average value 38.31 J/m. The result indicated that BB-PP is also resistant to damage caused by absorption of water and spills. The study shows that BB-PP has the properties as the average percentage of low water absorption is 0.277 percent. There is a significant difference in mechanical strength between BB-PP using the extrusion process. This validates that BB-PP has a mechanical strength of the Modulus of Elasticity (MOE); the flexural strength, tensile strength and Izod impact strength are high and obtained a good result. These advantages proved that combination of wood plastic composites is better than natural wood. All natural wood tend to swell and crack when exposed to water especially when exposed to rain or liquid spills. Therefore, the natural wood is often treated with chemicals to reduce water absorption. These chemical substances may be damaging and harmful to the environment. The bio-composite material used as car accessory to reduce the use of plastic and metal is an innovation in Malaysia. BB-PP material is suitable for extrusion process due to the character of the material that has high dimensional stability and durability. The use of bio-composite bamboo is widespread and useful in the design industry as it has many advantages over wood and other materials such as water resistance and it does not require treatment during the manufacturing process. Aesthetic in appearance, it looks like wood. However, when compared to wood, BB-PP is much better because it is resistant to insect and termite infestation. Production of car accessories from composite materials can further enhance the development of the car design industry. It is also as an alternative material to replace the high usage of plastic and metal.

This research is supported by Universiti Malaysia Sarawak research grant: DI/14/2010 (01).

Awards:

(i) Silver Award, Malaysia Technology Expo, MTE 20011

(ii) Gold Award, British Invention Show, BIS 2012



A car accessory (Steering wheel) made from bamboo using the polypropylene extrusion profile.



The design of the proposed car accessories made from bamboo using a polypropylene extrusion profile.

DEVELOPMENT OF LAMINATED INNER BAMBOO VENEER CAR SEAT

*Researchers: Abdul Ghafur Abdul Hamid and Khairul Aidil Azlin Abd Rahman
Institute of Design and Innovation, Universiti Malaysia Sarawak*



Figure 1: Inner bamboo veneer and compressed machine.



Figure 2: Finished product of laminated bamboo veneer car seat.

Bamboo species can be found widely in the Bornean forests and they are used widely by the natives. Bamboo is a unique material due to its strength, regenerative properties, and natural aesthetic value. The veneer traditional extraction and production process was pioneered by the Bidayuh community known as “Berapak”. This traditional method is to create craft product that measures between 30 cm wide and 76 cm long. The main objective of this research is to utilise the natural eco-friendly inner bamboo veneer material for a robust product design. The study emphasises the strength, durability, design, ergonomic, functions, manufacturability and environmental aspects that will benefit the users and manufacturers. According to the findings of this research, the bamboo can be used as laminated bamboo veneer and moulded furniture. The results show that the strength of the veneer obtained from the inner part of the bamboo can be classified in group no. 7 according to Malaysian Standard Code. Among the timber species that are classified in the same group no. 7 are Ara, Batai, Laran, Pulai, Sesenduk and Terentang. The veneer material is also suitable to produce furniture through a moulded process because the inner bamboo veneer is soft and easily shaped. The method of compressing the bamboo veneer sheet on a moulding machine (Compressed Machine) is shown in Figure 1. The results confirmed that the inner bamboo veneer sheet can be joined together and shaped perfectly to serve as moulded car seats as illustrated in Figure 2. The research shows that the Bamboo species which are considered “poor timber” has the potential to be popularised as high value-added products. The laminated bamboo board from the inner part of bamboo also has the potential to be commercialised as alternative material in the furniture manufacturing industry.

This research is supported by Universiti Malaysia Sarawak research grant: DI/14/2010 (01).

Awards:

- (i) Gold Award, Malaysia Technology Expo, MTE 20011*
- (ii) Gold Award, British Invention Show, BIS 2012*

ARCHETYPAL DESIGN AND IDENTITY OF TRADITIONAL SARAWAK MALAY HOUSE

Researchers: Adibah Binti Haji Yusuf, Khairul Aidil Azlin Abd. Rahman and Yakup Mohd. Rafee

Institute of Design and Innovation, Universiti Malaysia Sarawak

This research concentrates on the identity and archetypal design of the traditional Sarawak Malay house. A preliminary study was conducted to establish the design elements which are essential to form the identity basis of a house; a parameter to define a Sarawakian Malay house with special emphasis on the roof design. Field studies were conducted by the researchers in 76 Malay settlements throughout Sarawak. The Malay houses were illustrated in 3D drawing to allow a detailed observation of the roof forms and designs. From the samples chosen, two types of design were identified from the design of the roofs. They are the Saddle roof design and Gable roof design. From a plan view, the Saddle (Shed) roof design is rectangular in form. The upper part of the roof system has a ridge running horizontally, parting the two equidistant slanted downwards the roof surface thus forming a shape of an inverted "V" from a side view. Each end of the roof is fitted with gable screen which is locally known as *tebar layar*. In several samples, a tiny window with adjustable support is constructed on the slanted surface of the roof to allow cross ventilation and natural lighting. This window can be closed from inside the house if there is rain. Typically, the roofing material is made of *atap nipah* (roof thatching) but wealthier dwellers often install imported roof shingles instead. In Sarawak, the saddle roof design proved to be quite popular and it is more commonly known as shed roof design. From the district and village chief who were interviewed, many stated that shed roof design is widely used within the proletariat Malay communities of farmers and fishermen. Local aristocrats also employ shed roof design for their homes with additional decorative elements to distinguish their homes from those of the proletariat class. In Sarawak, the transformation from saddle roof house to gable roof house has taken place and therefore, a majority of existing Malay houses have the gable roof type. Many of the gable roof houses in Sarawak were built in similar height, except for several Malay settlements in Miri and Bintulu which were built slightly higher from the rest. The fact that these houses were built in locations close to the forest may have resulted in the construction of the houses at a higher level from the ground to keep the floor dry from a highly damp surrounding ground and to steer clear of wild animals. A higher floor level also keeps the house from being flooded during the rainy season.

This research is supported by Universiti Malaysia Sarawak research grant: DPI09/833/2012(02).



House at Kampung No.3, Jalan Ajibah Abol, Kuching, Sarawak.



House at Kampung Hilir, Sibul, Sarawak.



Remanufacture of used-products.

UTILISING SAGO BARK WASTE FOR VALUE ADDED PRODUCTS

*Researchers: Khairul Aidil Azlin Abd Rahman and Norhaizat Sundin
Institute of Design and Innovation, Universiti Malaysia Sarawak*



Figure 1: Harvesting sago palm and sago bark waste.



Figure 2: Sago bark flooring and decorative wall panels.



Figure 3: Sago bark occasional chair and woven sago bark.

In Malaysia, some of the agricultural wastes and their management practices pose significant environmental problems. The intention of the Malaysian Government to revitalise the role of agricultural sector in the development of Malaysian economy may have intensified these issues. Thus, the demand for better agricultural waste management is vital as agricultural wastes can directly and indirectly cause negative impacts on the environment, which could eventually affect the human health and welfare. However, agricultural wastes are potential resources as most of the wastes can be reprocessed and transformed into beneficial products. For example, the recycling or reusing of the sago bark which is an agricultural waste has been successfully demonstrated in this research. The research looked into the problems related to sago bark waste that were produced by sago production industries in Sarawak as shown in Figure 1. At present, sago bark is processed through the bio-composite method to produce sago plywood and particleboard, which have potential as building materials. Sago flours can also be used as an extended binder to minimise the volume percentage of resin. However, this process does not utilise the surface beauty and other natural features of the sago bark. As such, the research aims to produce a range of product such as flooring using the natural and unique texture of the sago bark. It also has the potential to develop products for the interior decoration purposes. For example, for wall decoration, furniture, flower pots, containers and decorative lightings with various shades and textures as shown in Figures 2 and 3. The simple methods used in producing these products are suitable to be applied and commercialised by the small scale industries. In conclusion, this research has successfully created value-added products that are good in aesthetic appearance, performance and reliability through the recycling of sago barks waste. Through the exploitation of sago bark waste, new promising materials can be proposed that are useful for global environmental conservation and sustainable development. This research is also one of the environmental strategies to balance sago waste production for the Sago industries.

This research is supported by Universiti Malaysia Sarawak research grant: 03(57)/499/2004(236).

Intellectual Property Patent Pending : PI20084752

Awards :

(i) Gold Award, Research and Development Exposition IPTA 2005

(ii) Silver Award, Geneva, Switzerland, 2006

COCKLE (*Anadara granosa*) SHELLS AS ALTERNATIVE MATERIAL IN FABRICATING ARTIFICIAL REEF

Researchers: Saiful Bahari Mohd Yusoff¹, Sylvester Wielding Jussem¹, Khairul Aidil Azlin Abdul Rahman² and Nurul Aniza Mijan¹

¹*Faculty of Applied and Creative Arts, Universiti Malaysia Sarawak*

²*Institute of Design and Innovation, Universiti Malaysia Sarawak*



Product validation conducted at Telaga Air.

Artificial reef has been proven to be an effective method to conserve marine life. However, issues on the impact of using hazardous materials as artificial reefs which include tyres and concrete structures in the marine eco-system and environment have become recent interests and concerns. Therefore, the main focus of this research is to develop an eco-friendly artificial reef using cockle shell as an alternative material. An attempt to use cockle shell in the fabrication of the reef was based on two reasons; to utilise waste material as an economic option and to benefit from the shell properties (mineral composition and rough texture). The proposed pyramid-shaped reef structure design is expected to improve stability against under water currents and stacking ability which can reduce the space and transportation issues. The experiments revealed that cockle shell improved the properties of concrete composition and can reduce or replace the use of gravel and sand. Apart from its natural ability to improve water pH, the mineral composition of calcium carbonate allows invertebrates like corals to attach on the structure. The integration of cockle shell on the surface of the reef has been proven to expedite the growth of marine organisms. The result of a simulated environment during the experiment has shown that the application of cockle shell as a surface texture has been found to be more effective at attracting fish than the smooth surface.

This research is supported by Universiti Malaysia Sarawak research grant: DI/15/2010(02).

Awards:

(i) Gold Award, National Research and Innovation Competition, 2010.

(ii) Silver Award, UNIMAS R&D Exposition, 2011.

AUTHENTIC CHAIR

Researcher: Saiful Bahari Mohd Yusoff

Faculty of Applied and Creative Arts, Universiti Malaysia Sarawak

To date, the product range created using the Ironwood of Borneo (*Eusideroxylon zwageri*) is mainly focused on antique furniture, which is entirely based on its natural shape. So far, there is no innovation to diversify and utilise the material for high-end furniture products. Authentic Chair is inspired by the combination of automotive and furniture designs which contribute to the central elements of the design as shown in Figure 1. The furniture created in this research highlights the environmental friendly concept, recyclable for both seat component and main wood structure. The seat is taken from a used sport car seat and has been ergonomically tested as shown in Figure 2. The wooden structure is made of Ironwood of Borneo (which is available only in Borneo) or also popularly known among the locals as *Belian*. It is an extremely durable and decay-resistant wood. It can withstand humid and wet weather and yet still maintain its shape and quality. This wood is also reputed to last for a few hundred years and has been used for construction of bridges, electric poles, longhouses, and ships. As such the stumps of logged *Belian* trees are still around decades after they were chopped down. For example in Sarawak, *Belian* stumps can be found near Batu Kitang river floor and Matang area in Kuching. The width of the chair is 720mm and the seating height is 340mm. The approximate weight of the chair is 20kg. There is a good potential for commercialisation of the product for high-end furniture suitable for interior use (as shown in Figure 3), the automotive manufacturers or at the car dealers' offices. Further collaboration can be carried out with automotive sport seat companies for better mass production and as a value added product. This product is also suitable as collector's item because of its unique features.

Award: Silver Award, UNIMAS R&D Exposition, 2011.



Figure 1: Authentic chairs.



Figure 2: Ergonomic validation.



Figure 3: Product proposal and setting.

HUMAN TRANSPORTER

Researchers: Saiful Bahari Mohd Yusoff¹ and Shaharudin Busri²
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²Mimos Berhad

Human Transporter (HT) has a unique design with an attractive appearance and innovative design based on the “function follow form” approach. HT also offers an alternative product package that is competitive with other international products. This project uses “A Class Surface” (similar evaluation used to assess the production automotive surface used in the automotive production). In transforming the automotive design approach through combining the knowledge between academia and local industry experts, the researchers have considered the usage of air compressed engine technology to help contribute to the health of the environment. Human Transporter is a four-wheeler vehicle and a new segment of vehicle that combines the concept of an automobile and motorbike. The arrangement of the seats is based on the body vehicle and the HT is stable, fun to drive and yet stylish in design. The main rider is positioned outside the vehicle’s body while the passenger is seated in a spacious space at the inner side of the front part of the vehicle. If there is no passenger, the passenger space can be transformed into a storage space.

This research is supported by Universiti Malaysia Sarawak research grant: DI/11/2009(01).

Awards:

- (i) Malaysia Design Award, 2009
- (ii) Innovation and Technology Exhibition (ITEX 2010).



Figure 1: ¾ Rear HT design proposal.



Figure 2: ¾ Front HT design proposal.



Figure 3: Proposed product variation for different market segment.

ALTERNATIVE JELATUNG DESIGN FOR THE RURAL COMMUNITY OF SARAWAK

Researchers: Saiful Bahari Mohd Yusoff, Ringah Kanyan, Sylvester Wielding Jussem and Shah Jhihan Abdullah

Faculty of Applied and Creative Arts, Universiti Malaysia Sarawak

The reliance on rivers is very significant in Sarawak because the state's geographical landscape is formed by many tributaries of rivers that flow into the deep interior. The river is the most important traditional link especially for both coastal and inland communities to commute from coastal areas to the hinterland and vice versa across the island of Borneo (Sabah and Sarawak, Malaysia and Kalimantan, Indonesia). For the coastal communities along the major rivers in Sarawak, the term *Jelatung* may not be so strange to them. The word *Jelatung* is a term in Iban language which is also adopted by other ethnic groups in Sarawak. *Jelatung* refers to the platform that is built on floating logs and installed by the river or lakeside which faces the longhouses and traditional villages. In terms of function, the *Jelatung* is used for various purposes. Through observation and research, Tatau river in Bintulu Division (Kuala Tatau, Tatau Town, Kakus river-Lubuk Kubung and river Anap-Kampung Pasir Nangka) and Teru River, a tributary Baram River in Miri (which includes Logan Bunut Bunut River and Tinjar river) still has many *Jelatungs* - more than anywhere else in the state. However, this preliminary observations also showed that the quantity of the traditional *Jelatung* has reduced significantly due to several factors, such as the lack of desirable quality and size of timber that are suitable for the construction of *Jelatung*, geographical factors (changes in river flow), and the destruction of existing *Jelatung*. Therefore, this study aims to examine the application of materials used in the manufacturing of modern *Jelatung*, taking into account the safety elements.

This research is supported by Universiti Malaysia Sarawak research grant: 03(S62)751/2010(37).

Award: Silver Award, UNIMAS R&D Exposition, 2011.



Existing *Jelatung* used by villagers at river Tinjar in Miri.



Proposed *Jelatung* design from ergonomics study.

LAPTOP CARRIER FOR RESEARCHER

*Researchers: Saiful Bahari Mohd Yusoff and Wilson Robert Sabang
Faculty of Applied and Creative Arts, Universiti Malaysia Sarawak*

In general, the laptop carrier is seen as an increasingly important product. The research is to evaluate the design of a laptop carrier which can be used in the forest by researchers while carrying out their research. Early research has found that other research groups such as the National Security Forces and Police Field Force require such products for their tasks in the forest. Based on the pilot study, the existing laptop carriers are not user friendly as most respondents encountered difficulties while collecting data in the forest. It also has a very limited space and usage. The design of laptop carrier enables users to move around while typing on their laptops, thereby reducing time as well as energy. Therefore, the main purpose of this research is to identify design problems in the existing laptop carriers in order to propose an improved version which allows the users to carry out their research activities efficiently during field work.

This research is supported by Universiti Malaysia Sarawak research grant: FPI(F03)/149/ /2013(16).

Awards:

- (i) Silver Award, National Research and Innovation Competition, USM, 2012.*
- (ii) Silver Award, UNIMAS R&D Exposition, 2013.*



Laptop carrier design presentation.



Proposed design of the laptop carrier.

