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Design of Functional Racing Singlet for the Hong Kong Rowing Team

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PolyU UoA 38

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Design of Functional Racing Singlet for the Hong Kong Rowing Team

Descriptor

In the past, the athletes of the Hong Kong rowing team purchased racing singlets from overseas companies. However, the team found that there were problems with the singlets, such as poor fitting and scratchiness caused by improper fabrication, seams, and types of stitching. In this project, a totally new uniform was designed that improved all of these aspects. The project team also established a new technical manual as a benchmark which had not been implemented for the Hong Kong rowing team previously.

During the research process, the project team first adopted tailor-made approach (by using a 3D body scanner) to achieve the extreme-fit expectation of each athlete. To improve the function of the singlet, we designed a list of fabric tests to ensure the quality of the materials. Sweating thermal manikins were used to evaluate the thermal comfort of the singlet. Furthermore, UV protection was added in this new prototype. Wearer trials were conducted during the rowers pre-race practices overseas. An online questionnaire was designed for the rowers, and the data was used to evaluate the ultimate performance of the final prototype.

This project successfully received an Innovation and Technology Fund (HKSAR government) for a total amount of over HK\$700,000. The impact of the project was not limited to the rowing team winning the first-ever gold medal in the Asian Games 2014; other sports teams have taken the new technical manual as a reference to develop their uniforms. The CEO of the Hong Kong Research Institute of Textiles and Apparel (HKRITA) “shared the research results and innovative technologies with the trades, to enhance the competitiveness of local textile industry” (see p. 25 - report link). In fact, HKRITA developed another rowing racing singlet for the 2016 Olympic Games by referencing this technical manual and research methodology. (296 words)

Researcher's background

Dr. Ho's research focus is on the investigation of functional clothing. He had experience to design functional uniform for Hong Kong sport team and adaptive clothing for health care centres. Apart from the practice-based research, he also investigates the relationship between design and comfort level of clothing with the support of scientific data. The examples included the development of design details to enhance garment's thermal comfort; and the evaluation of garment construction to fit Chinese men with apple body shapes.

What constitutes the research output / body of work

1. Racing suit for the Hong Kong rowing team (Aug 2014)

200 sets new racing singlet for the Hong Kong rowing team for assisting them in their upcoming competition included Asian Games 2014. The elite team could also receive the suit for other local or international competitions.

2. Academic publication (2016)

The background, methodology, design of new suit and product evaluation were reported in an academic paper which was published in 2016.

3. Technical report to Hong Kong Sports Institute (2014)

The product specifications, full data of fabric testing and rowers' evaluation were submitted to Hong Kong Sports Institute for reference of racing suit development in the future.

4. Media coverage (included exhibition, newspaper report and online document/videos) to promote the collaboration and the promising result under this project (2014-2015).



Research context

The current rowing singlets were purchased from an online shop of an overseas company which specially produces rowing singlets. After the focus group interview, the rowers addressed the following key problems that they found with the current singlet:

- Poor garment fit;
- Scratchiness on the seam, armhole and crotch part (for male rowers)
- No wicking function on the fabrics

Previous studies have summarised that except for sport equipment, the body positions and garments of athletes are the two most crucial factors affecting athletic performance (Chowdhury et al., 2009; Kyle, Brownlie, Harber, MacDonald, & Norstrom, 2004; Moria et al., 2010).

In the first phase, the coach and the rowers defined the preliminary problem.

Then we ideated and refined design ideas during the second phase.

After defining the key problems of the current singlet, we worked with the rowers, coach, and garment manufacturer to suggest possible. After fine-tuning the details, a final design was approved and delivered to the rowing team for their participation in the 2014 Asian Games.

This project was totally funded (HK\$ 0.7 M) by the Hong Kong Government (Innovation and Technology Fund)

Research questions

The research sets out to

1. To review the limitations of the current racing suit that the rowing team was using for years, include size and fit, fabric, construction and design details;
2. To design new racing suit to improve athlete's performance in body movement and thermal comfort;
3. The degree to which the modified cutting, size, construction and stitch of the new racing suit can eliminate all the uncomfortable experiences caused by the current racing suit.
4. To establish a new set of testing standards (e.g. fabric properties, thermal resistance, etc.) for further re-ordering and product development

Research material

Rowing is an activity which requires participants to use their whole bodies in a sitting position. Rowers must propel a boat using their arms, legs, back, and shoulders, executing all movements within the vessel. An appropriate racing singlet designed for their unique movements is essential for professional athletes' training and competition. With the support by the government's research fund, we collaborated with a garment manufacturer, and the Hong Kong rowing team to develop a new singlet for their participation in the 2014 Asian Games. A design process framework developed by LaBat and Sokolowski (1999) was adopted to facilitate the design process (Ho & Au, 2016).



The new design of racing suit for the Hong Kong rowing team
Photo source: HKRITA, 2016

Research material

The Hong Kong flag on the racing suit

Traditional embroidery unavoidably exposed sewing thread on the wrong side of the suit, which might cause friction to the skin of the chest. The national flag at the front was changed from embroidery to a heat-transfer PU badge to make maintain the smoothness of the wrong side of the fabric. In addition, the research team observed that current embroidery badge might have puckering appearance on the fabric which was caused by the penetration of the embroidery thread. This puckering effect is not uncommon when embroidery is applied to a stretchable fabric. However, this penetration was not applied to heat-transfer PU badge. To solve the puckering problem, the research team proposed either screen print or heat-transfer PU badge to create the Hong Kong flag on the new rowing suit. After the comparison of the trial samples and costing, all parties agreed to use the heat-transfer PU badge (Ho & Au, 2016).



Current embroidery badge



Heat transfer PU badge

Research material

Crotch construction of the new singlet for male rowers

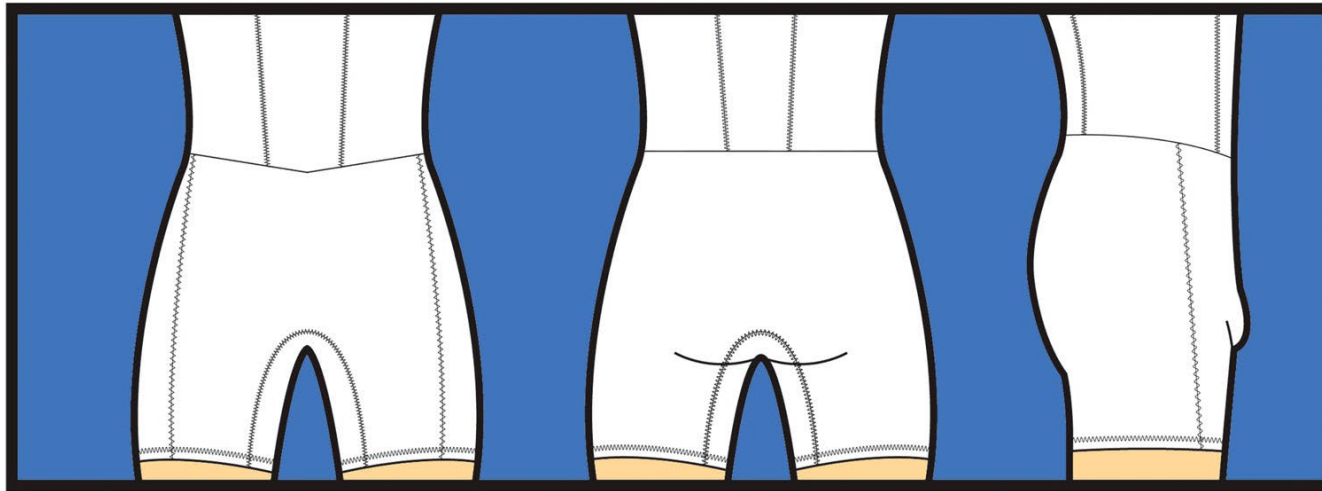



Photo source: Ho, C. and Au, Y. 2016. Development of functional racing singlet for professional rowers, *International journal of fashion design, technology and education*, 10(2), 137-145.

The crotch was cut according to the body shape of the male and female rowers. The centre front seam and centre back seam were removed from each singlet. A gusset was added to the female singlets to increase flexibility; thus, only one centre back seam was constructed as a joint in the lower half of the singlet. For the male rowers, a rectangular panel was constructed to eliminate the bulkiness of the seams. Two seams were constructed along the front side panel in accordance with the body shape of the rower. These two seams were essential in forming a tube-like bottom half and ensuring that there was no seam on the back. All seams at the crotch were constructed with flatlock seam 607 cover stitch (ASTM D-6193) (Ho & Au, 2016).

Research material

Design sketches:

Rowing unisuit



Technical Details:

1. Joining seam: covering stitch
2. Collar, armhole and hem: rolling seam
3. No side-seams at both sides
4. Hong Kong flag logo: PVC heat transfer badge
5. HKRITA logo: rubber print (Hem logo size: 38mm x 13.9mm)/Back logo size: 38mm x 25mm for female/ 51mm x 32.7mm for male)

Testing Samples in Condition 1 (Set: Temperature 25°C; Humidity 76%; No air velocity)/ (Actual: 25.5°C; Humidity 79%; No air velocity)

1) Skin Thermal Sensation: (-3 Cold to 3Hot)

	R1A	O1A	R2A	O2A	R3A	O3A
0mins	1	0	0	1	1	1
15mins	0	1	0	0	1	2
30mins	1	2	0	1	1	1
45mins	0	0	-1	0	1	2
Mean	0.5	0.75	-0.25	0.5	1	3.75

2) Skin Humidity Sensation: (1 Dry to 7 Very Wet)

	R1A	O1A	R2A	O2A	R3A	O3A
0mins	1	2	1	1	2	4
15mins	2	2	1	1	2	4
30mins	2	3	2	2	3	4
45mins	2	2	2	2	3	4
Mean	1.75	2.25	1.5	1.5	2.5	4

3. Overall Comfort: (-3 Very dissatisfied to 3 Very satisfied)

	R1A	O1A	R2A	O2A	R3A	O3A
0mins	0	2	3	1	2	-2
15mins	1	-1	2	1	1	-2
30mins	2	-1	1	1	0	-2
45mins	1	1	2	1	1	-2
Mean	1	0.25	2	1	1	-2

The example of the technical report submitted to Hong Kong Sports Institute:
Product specification (left);
Lab result of the new racing suit (right)

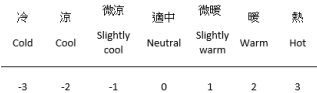
Research material

1.1) 測試進行前 Before Wearer Trial

0 ~ 15 mins

- 1) 称重 (測試者和衣服) Mass of subject and clothing
Subject _____ G Clothing _____ G
- 2) 舒適度主觀評價 Subjective Comfort Evaluation :

a. 皮膚溫度感條 Skin Thermal Sensation



總體感條 Total

胸部 chest

肩部 Shoulder

上背部 upper back

	極度不滿意	很不滿意	輕微不滿意	適中	輕微滿意	很滿意	極度滿意
整體舒適度		8.33%			25%	41.67%	25%
吸汗性		8.33%	8.33%		25%	33.33%	25%
透氣度		8.33%			25%	41.67%	25%
尺寸		8.33%	8.33%	25%	16.67%	16.67%	25%
線條及剪裁		8.33%		16.67%	16.67%	33.33%	25%
布料拉伸性		8.33%		25%	25%	25%	16.67%
重量		8.33%		25%	25%	8.33%	33.33%
領口設計—整體舒適度		8.33%			16.67%	41.67%	33.33%
夾層設計—雙臂伸展性		8.33%			8.33%	58.33%	25%
滾邊設計—整體舒適度		8.33%	8.33%	16.67%	16.67%	33.33%	16.67%
腰部設計—伸展性		8.33%		8.33%	33.33%	33.33%	16.67%
大腿設計—鬆緊度		8.33%	16.67%	16.67%	25%	8.33%	25%
大腿設計—伸展性		8.33%	16.67%	8.33%	33.33%	16.67%	16.67%
肩部設計—肩帶的伸展		8.33%		8.33%	8.33%	58.33%	16.67%
背部設計—伸展性		8.33%			16.67%	50%	25%
縫線部分—伸展性		8.33%		8.33%	25%	33.33%	25%
縫線部分—整體舒適度		8.33%			33.33%	25%	33.33%
縫線部分—光滑度		8.33%		8.33%	16.67%	41.67%	25%
微章部分—整體舒適度		8.33%			8.33%	41.67%	41.67%

Q1 Opinion on NEW unisuit

The example of the technical report submitted to Hong Kong Sports Institute: Questionnaire sample (left) and its result (right)

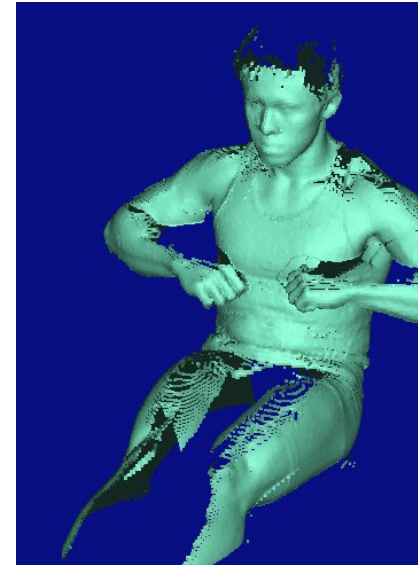
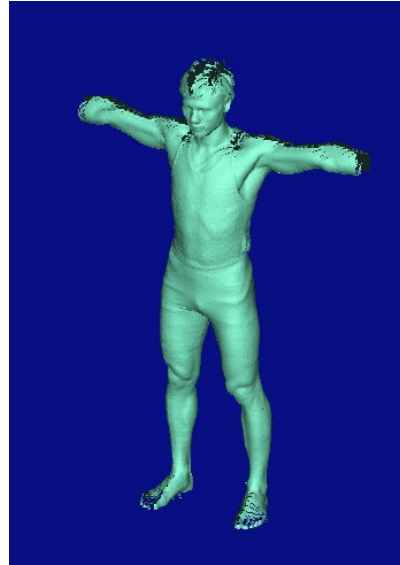
Research methodology

3D body scanning and tailor-made approach for each rower

Tailor-made approach to eliminate fit problems

The research team realised that mass-produced singlets could not satisfy the individual fit requirements of each rower because of the limited size range. Rapid prototyping of high performance sportswear. Researchers stated that garment construction affects the effectiveness of specific active wear. A proper fit plays an essential role in the development of high-performance sport clothing. This garment should allow the athlete to move freely, but at the same time it would not create extra fabric drape to hinder the body movement. However, it is difficult to design and develop commercial sport clothing to fit every unique body. Hence, the production of tailor-made singlets was proposed for the rowing team in this study.

In order to realise the body stretching of the rowing exercise, a 3D body scanner was adopted to capture the figures. The data was then use to estimate the ease allowance of the racing rowing suit for individual player (Ho & Au, 2016).



Research methodology

Wearer trial and subjective measurement (questionnaire)

Wearer trials

The research team divided the wearer trial into two phases, which were conducted in Hong Kong and oversea training or competitions.

To obtain their feedback, face to face interview and online questionnaire were proceed to evaluate their comments on overall comfort, size and fit, fabrication, seam construction, new Hong Kong badge and other design details.

The feedback and questionnaire were analysed and following up action was taken to improve the suit during the wearer trials (Ho & Au, 2016).



Research methodology

Fabric lab test

Before deciding on the fabric for the first prototype, a series of tests were conducted for fabric appearance, breathability, colourfastness, and other properties. The following table presents some of the testing standards and methods of this project. The cost, weight, and performance under a series of lab tests were key considerations in producing this functional athletic singlet. The final selection for the prototype was a blend of 92% polyester with 8% spandex and a weight of 200 g/m2, constructed in fine gauge interlock fabric. The elastomeric behavior of spandex has made it a popular choice for underwear, outerwear, and active wear (Singha, 2012). Because the male rowers did not wear underwear during rowing, a thicker fabric was used (92% polyester with 8% spandex in the weight of 230 g/m2) to avoid transparency in the lower half of the singlet (Ho & Au, 2016).

Type of testing	Details	Standard
Fabric appearance	After washing and dry clean	AATCC 124-2006
Colour fastness	Laundering; dry clean; crocking; perspiration (acid and alkali); sea water; light	AATCC 61-2006 AATCC 132-2013 AATCC 8-2005 AATCC 15-2009 AATCC 106-2013 AATCC 16-2004
Dimensional change	After washing and dry clean	AATCC 135-2004
Breathability	Air permeability	ISO 9237:1995
	Water vapour permeability	ASTM E96/E96M-13
Bursting strength	Fabric surface and seam	ASTM D3786-06 ASTM D3786/3786M-13
Pilling resistance	Fabric surface	ASTM D3512-10
Abrasion resistance	/	ASTM D4966-12
Seam stretchability	/	AATCC TS-015
UV resistance	/	AS/NZS 4399:1996

Source: Ho & Au, 2016

Dissemination and distribution of outcomes

Year	Details
Academic publication	
2016	Ho, C. and Au, Y. 2016. Development of functional racing singlet for professional rowers, International journal of fashion design, technology and education, 10(2), 137-145. https://doi.org/10.1080/17543266.2016.1221144
Online documentary by HKSAR or other professional institutions	
2015	Development of Smart Interactive Functional Clothing. YOUTUBE clip published by Hong Kong Research Institute of Textile and Apparel. 2015
2014	Custom suit bolsters paddle power. Report & Movie published by Information Services Department, HKSAR. 2014
2014	Rowing hear enhances athletes' performance. Excel @ PolyU. Issue 65. Nov 2014
Artefact	
2014	Racing suit worn by the Hong Kong rowing team at Asian Game 2014
Exhibition	
2014	Exhibition at <i>InnovCarnival 2014</i> (organized by Innovation and Technology Commission, HKSAR). Hong Kong Science Park. Hong Kong. 1-9 Nov, 2014
Newspaper report	
2014	<i>High Performance Rowing Suit</i> . HK Textiles Report. Issue 120. 20/3/2015
2014	"The First Gold Medal for Rowing Team - Application of Research and Technology Achieves the Sports Development", Hong Kong Ming Pao Newspaper. 7/11/2014
Evaluation report by collaborator	
2014	Evaluation: reported by the Hong Kong Sports Institute (After completion of the garment-funded project)

Dissemination and distribution of outcomes

Artefact: Racing suit worn by the Hong Kong rowing team at Asian Games 2014



Photo source: Hong Kong Sports Institute

Dissemination and distribution of outcomes

Exhibition at InnovCarnival 2014 (organized by Innovation and Technology Commission, HKSAR)



Hong Kong rowing team and the new racing singlet

Dissemination and distribution of outcomes

HK Textiles Report. Issue 120. 20/3/2015

High performance rowing suit .



紡織新技術

香港紡織商會
HK GENERAL CHAMBER OF TEXTILES

高性能賽艇服



划艇是一項坐在艇中進行的全身運動，健兒用雙臂、雙腿、背部及肩膀來推動船隻前行，一套適合這種獨有動作的划艇服對專業運動員十分重要。

香港體育學院早前邀請香港紡織及成衣研發中心與香港理工大學合作，由創新及科技基金贊助下，為香港賽艇隊選手設計高性能賽艇服出戰2014亞洲運動會。香港代表於運動會贏得一金四銀的好成績，其中在男子輕量級單人艇項目摘下的金牌更是香港賽艇歷史上首面亞運金牌！

立體量裁

運動員划艇時，背部微曲，四肢大幅伸展，不斷重複同一划艇動作。運動服要是不稱身，又或用料容易磨損皮膚，會大大影響比賽表現。因此，划艇運動服的物料、剪裁要特別設計配合賽艇運動員訓練和比賽環境的需要。所以研究小組先以立體人體掃描法為每位選手量身，按所得的尺碼製作運動服，再經多輪試身及調整，每件都獨一無二。

嶄新物料

研究小組再考慮划艇運動的特性，練習及比賽時的天氣情況，為布料的重量、強度、伸展性、回彈性、耐磨性及防紫外光功能進行測試。頂級比賽中，極小的重量變化都可以是金牌與銀牌的分別，所以設計着重減輕衣服重量，同時，研究小組亦透過出汗暖體假人測試織物的散熱、吸濕和舒適度的分析結果，選擇最適合的物料來製作高性能賽艇服。

該項目既為賽艇選手提供高效能的運動服，研究掌握的創新技術亦與業界分享，協助他們提升競爭力。研發中心將繼續與香港體育學院計劃合作，進一步改善運動服的設計，為香港代表隊提供更理想的高性能運動服。

香港紡織及成衣研發中心 總監(研究及發展)何繼超博士

Information from "New Textile Technology", Hong Kong Textiles Report, issue 120

Dissemination and distribution of outcomes

HK Textiles Report. Issue 120. 20/3/2015 (Con't, and translate to English)

Textile Technology Advancement

Highly Functional Rowing Suit

Rowing is a full-body workout under a sitting position in rowboats. Given that athletes have to engage their arms, legs, back and shoulders to propel the boats, a set of jersey that accommodates this unique kind of movement is extremely important for professional rowers. The Hong Kong Sports Institute (HKSI) previously invited the Hong Kong Research Institute of Textiles and Apparel (HKRITA) for a collaboration sponsored by Innovation and Technology Fund and designed highly functional rowing suits for the Hong Kong Rowing Team participating in the Asian Games 2014. The Hong Kong representatives passed with flying colours of 1 Gold and 4 Silver medals, among which the gold medal from Men's Lightweight Single Sculls marks in Hong Kong rowing history the first gold from Asian Games!

3D Cutting

When the athletes row, they slightly bend forward and stretch their limbs to a great range and keep repeating the same rowing movement. If the jersey does not fit well, or if its fabric rubs and hurts their skin, their performance would be greatly affected. Therefore, the fabric and the cutting of the jerseys should be specially designed according to training needs and race environment. For this reason, the research team would measure for each rower with 3D scanning technology, then make the jersey according to the measurements, following by repeated fitting and adjustment. As a result, each piece is one and only.

Newly Developed Materials

After close consideration of the characteristics of rowing and the weather conditions of practice and games, the research team tested on various features of the fabric including weight, strength, flexibility, elasticity, abrasion resistance and UV resistance. In world-class top games, any slight weight difference could be the endgame for gold and silver medal, so weight reduction is the major concern with regards to jersey design. Meanwhile, the research team also tested the textiles on their cooling effect, breathing effect and comfortability with a perspiring thermal mannequin, and chose according to the analysis result the most suitable material for creating the highly functional jersey.

The project is not only dedicated to developing functional jerseys for the rowers, but is also aspired to share the team's advanced technologies with the industry in order to raise their competitiveness. HKRITA will continue to collaborate with HKSI for further projects and advance the design of the jerseys, so as to offer the Hong Kong team with highly functional jerseys in perfection.

Dissemination and distribution of outcomes

"The First Gold Medal for Rowing Team - Application of Research and Technology Achieves the Sports Development"

Interview - Hong Kong Ming Pao Newspaper. 7/11/2014 (translate to English)

HK Rowing Team Wins First Gold Medal in Asian Games

High-tech Jerseys Promote Sports Development

The Hong Kong Rowing Team has achieved a fruitful result with 1 Gold and 4 Silver medals in the 17th Asian Games Incheon. Before they set off, all team member stood side by side showcasing their uniform jerseys in strong vigor and high spirit. Their confidence conquers all before the starting pistol. The Gold fetcher Jersey is a product of the dedicated collaboration of The Hong Kong Research Institute of Textile and Apparel with the Hong Kong Polytechnic University in six-month time. Being extra-thin and light, the jersey is slim and breathable. Printed with the signature colour and emblem of the HKSAR, it honours our athletes with endless confidence and immense power, to exhibit the ever-striving Hong Kong spirit.

The Rowing Team's striking victory is not only a combined effort of the athletes, who attend progressive training to improve body conditions and techniques, and the coach, who brushes up their techniques and adjusts their mental conditions, but it also includes contribution from the crew in researching, developing and designing the jerseys. As jerseys are close companions of athletes, in order to let them coordinate well for outstanding performance, perfection work for the jerseys is indispensable. Therefore the Research Team would scan each athlete and create tailor-made jerseys for them.

(Picture) Ho Chu Po pointed out that factors for developing rowing jerseys include weight, cutting design and functionality of fabrics to accord with the needs in the athletes' movement.

The Lighter on the Rowboat, the Better the Performance

'Since rowing athletes have to go through weight check before games, our research team places high emphasis on the weight of jerseys. For instance, it is important for a one-piece vest-cum-shorts to not only fit well and comfortably, but to be light and thin, while every single pieces of thread and print is carefully designed. The current jersey is 0.2kg lighter than the previous one. This reduces the burden on the athletes, and thus enhances their performance in games,' said Dr. Ho Chu Po from the Institute of Textiles & Clothing, the Hong Kong Polytechnic University, who led the development of this jersey. 'For the cutting, our research team has picked some jerseys from other countries for research and improvement, then employed 3D cutting and tailor-made the jerseys according to each athlete's body figure. We are aware that specific movements of upper limbs/arms, legs, back and shoulders are made when athletes sit rowing the boat. Hence when we designed the cutting, we tried to accommodate their postures and movements by making deeper cutting lines at the armpits. We also reduced stitches at each seam to keep the inner face smooth and avoid rubbing against the rowers' skin. Meanwhile, we assured that the fabric possesses functions such as flexibility, breathability, abrasion resistance, cooling effect, moisture control and UV resistance, etc., to achieve a closefitting and comfortable touch.'

Dissemination and distribution of outcomes

"The First Gold Medal for Rowing Team - Application of Research and Technology Achieves the Sports Development"

Interview - Hong Kong Ming Pao Newspaper. 7/11/2014 (con't)

Fabric Breathability Dedicated for the Needs

According to Dr. Gloria Yao, Senior Research Manager of the Hong Kong Research Institute of Textiles and Apparel (HKRITA), rowing is practised under specific environment and conditions. The entire research and development process was in short timing and very challenging; they only had a few months, but in order to help the rowers perform their best, the research team speeded up procedures including fabric tests, fulfilment of comfortability in hot and moist conditions, etc. Eventually, the team succeeded in developing highly functional jerseys, including the one-piece vest-cum-shorts and the heat insulating sweater and coat. This was absolutely a heartening encouragement for all. The team would continue to develop professional jerseys for rowers at different levels so that they could perform their best under all kinds of weather conditions.

(Picture) Dr. Yao (left) and Chan Yan both believed that the scientific technology of HKRITA can be applied in various fields and can effectively enhance living quality of Hong Kong people.

Scientific Technology for a Wide Coverage

'The HKRITA have had multiple collaboration projects with the Hong Kong Sports Institute (HKSI) in using scientific technologies to help enhance athletes' performances. Apart from perfect teamwork with HKSI, we also cooperate with various sectors such as different elderly homes in the social welfare sector. For example, the team designed and developed outfits for the elderly with fabrics that protect against physical impact. When they tumble, the force can be shared to minimise injuries. At the same time, the team developed an automatic anti-bacterial cleaning spray for residential care centers. The spray contains no harmful substances and has a function of degrading dirt automatically. Technology developed by the institute has wide applications, such as the reusable elastic fabric. This fabric can be used in the healthcare industry for rehabilitation; it can also be used for underwear production through collaboration with underwear garment companies. Our technology belongs to the applied science and enjoys broad usage; it can promote the development in the industry and benefit different fields and society,' said Chan, the Director of the HKRITA.

(Picture) Group photo in Innocarnival 2014 of HKRITA, Representative of the Institute of Textiles & Clothing of the Hong Kong Polytechnic University, and Hong Kong Rowing representatives for the Asian Games.

Dissemination and distribution of outcomes

"The First Gold Medal for Rowing Team - Application of Research and Technology Achieves the Sports Development"

Interview - Hong Kong Ming Pao Newspaper. 7/11/2014 (con't)

Continual Research Effort for Olympic Games

Chris Perry, head coach of the Hong Kong Rowing Team, indicated that rowing is a full-body workout in a sitting position. When the athletes row, they need to pull with all muscle strength, slightly bending forward, to stretch their limbs to a great range and keep repeating the same rowing movement. If their jersey does not fit well, it rubs and hurts their skin easily, greatly harming their performance. Therefore, the fabric and the cutting of the jerseys should be specially designed to be light, thin and comfortable all in one. In the future, HKRITA will continue to collaborate with HKSI to help develop rowing jerseys that counteract different weather conditions, such as humid and freezing cold environment, in hopes of bringing its functionality to another level and better preparing the Hong Kong team for the Olympic Games 2016.

(Picture) Perry indicated that the HKSI would continue its collaboration with the HKRITA and engage in enhancing the functionality of the jerseys to bring better results in games.

(Picture) Lok Kwan Hoi told that the new jersey is lighter than the previous one, and this brings better performance in games.

Close-fitting Jersey for the Body Figure

Lok Kwan Hoi, who won the gold medal in 17th Asian Games Incheon, defeated competitors from South Korea and India in the Men's Light weight Single Sculls.

'Weight is a great concern in rowing, especially for the lightweight class. Even a small increase in 0.1kg makes a great difference for the athletes. The newly developed jersey allows me to move freely my upper limbs and shoulders. The movements are made easier and more comfortably. Also, the jersey is lighter than the previous one, so I can consume more food and drinks for more energy to be dissipated during games,' Lok said. 'The jersey fully demonstrates the perfect body figure of the athletes, which greatly boosts our confidence. Being well-fit yet flexible, it also allows us to be care-free and comfortable during rowing. Most importantly, the jersey breathes well. I don't feel stuffy even after sweating in training, as it dries instantly. The fabric also blocks UV light so that we are protected even under scorching sun,' said Li Ka Man, another major rower in the team who has attended the Asian Games for many times and clinched a silver medal.

(Picture) Li said that the new jersey fully demonstrates the perfect body figure of the athletes, which greatly boosts their confidence.

Dissemination and distribution of outcomes

Report & Movie published by Information Services Department, HKSAR. 2014

Title: Custom suit bolsters paddle power.

Video Link: <https://www.youtube.com/watch?v=GkUec6SZdNs>

Report Link: http://www.news.gov.hk/en/categories/health/html/2014/08/20140822_125338.shtml

Health & Community

Please Select

Custom suit bolsters paddle power
August 24, 2014

Clothes may not make the man, but a tailor-made racing suit could help make champions of the 10-member **Hong Kong Rowing Team** at the 2014 Asian Games in Incheon, South Korea next month.

The **Hong Kong Research Institute of Textiles & Apparel** and Hong Kong Polytechnic University's Institute of Textiles & Clothing teamed up in February to develop the high-tech suit. The one-piece short and vest combination is ultra-thin, ultra-lightweight, breathable, and UV and wear-resistant.

To ensure a custom fit, each of the elite athletes underwent a three-dimensional scan that collected their precise measurements. The institutes developed several prototypes for fitting, adjustment and improvement before producing the finished cutting-edge racing suits.

Raising standards: Hong Kong Research Institute of Textiles & Apparel's Chief Executive Officer Edwin Keh (second right) said the institute will share its research results and innovative technologies with the trades to enhance their competitiveness.

02:48 03:54
Video 1 / 1 [Download Video](#) | [Display Transcript](#)

Dissemination and distribution of outcomes

YOUTUBE clip published by Hong Kong Research Institute of Textile and Apparel. 2015
Title: Development of Smart Interactive Functional Clothing.

Video link: <https://www.youtube.com/watch?v=lo8F4LnNsu0&t=14s>



Dissemination and distribution of outcomes

Report on Excel @ PolyU. Issue 65. Nov 2014

Title: Rowing gear enhances athletes' performance.

Link: <https://www.polyu.edu.hk/cpa/excel/en/201411/viewpoint/v1/index.html>

excel@PolyU

November 2014 Issue 65

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Rowing gear enhances athletes' performance

Rowing gear enhances athletes' performance



The Hong Kong Rowing Team has achieved excellent results at this year's Asian Games held in Incheon, South Korea. Contributing to the success is the rowing gear jointly developed by PolyU and the Hong Kong Research Institute of Textiles and Apparel. Sportswear is the irreplaceable companion of every athlete. In this issue, Dr. Ho Chiu-yeung (right) is shown at the PolyU Institute of



Dissemination and distribution of outcomes

Evaluation report issued by Hong Kong Sports Institute

V. Feedback / Evaluation from User(s) (to be completed by the user(s) / user organisation)(Note)

(Note: the Project Coordinator should collect feedback from each user or user organisation who/which should each complete section V separately and enclosed with the report.)

1. Are you satisfied with the trial results delivered?

☒ Satisfied

☐ Not satisfied. Reasons: _____

2. Do you think that the project results / technology will bring benefits to the operation of your organisation(s)?

☒ Yes → Go to Q3 and Q4

☐ No → Go to Q5

3. In what area(s) do you think the project results / technology are of benefit to your organisation? (Please indicate by putting in '✓' to all applicable choices)

☐ Improve production capability

☒ Improve product quality

☐ Improve service quality

☐ Reduce production / product cost

☐ Enhance job opportunities

☒ Gain reputation from the industry

☐ Process enhancement

☒ Others (Please specify Enhance performance of Hong Kong Elite Athletes)

4. Are you willing to adopt the project results / technology if they are available in the market (e.g. through tender or procurement)?

☒ Yes/Likely. Details of any plan to procure the service/product (if any): _____

☐ Not sure. Reasons: _____

☐ No/Unlikely. Reasons: _____

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5. Why do you consider the project results not useful to your organisation? (Please indicate by putting in '✓' to all applicable choices)

☐ The prototype or trial results/ technology are not delivered as expected

☐ The project results / technology are no longer relevant to the needs of my organisation (Reasons: _____)

☐ Not cost effective for my organisation to realise / make use of the results

☐ Others (Please specify _____)

6. Do you have any suggestions for further improving the project results / technology from a user's point of view?

The final outcome of this project was extremely satisfactory from the end-user point of view. The product quality was high and used a number of innovative concepts. The Hong Kong Team used the finished product at the 2014 Incheon Asian Games – winning medals.

Further research and development could be undertaken to examine adaptations for different climates.

7. How satisfied are you with the overall performance of the Project Coordinator or project team (e.g. in terms of management of the trial or assisting users to make use of project results / technology)?

The project was extremely well run and coordinated. Due to the tight training and competition schedule of the Hong Kong Rowing Team, all of the project milestones had to keep to an exact time frame. This was fully achieved. Coordination / communication with all participants was clear and efficient.

(To be signed by user / representative of user organisation)

Signature: _____

Completed by
(Name / Post / Organisation):

Chris Perry
Head Rowing Coach / Hong Kong Sports Institute

Tel. No. / Email address:

90358280 / cjperry@nelvigator.com

Date of Completion: _____

References

- Boorady, L. M. (2011). Functional clothing – principles of fit. *Indian Journal of Fibre and Textile Research*, 36, 344–347. Bye, E., & Hakala, L. (2005). Sailing apparel for women: A design development case study. *Clothing and Textile Research Journal*, 23(1), 45–55.
- Chowdhury, H., Alam, F., & Mainwaring, D. (2011). Aerodynamic study of ski jumping suits. *Procedia Engineering*, 13, 376–381.
- Chowdhury, H., Alam, F., Mainwaring, D., Beneyto-Ferre, J., & Tate, M. (2012). Rapid prototyping of high performance sportswear. *Procedia Engineering*, 34, 38–43.
- Chowdhury, H., Alam, F., Mainwaring, D., Subic, A., Tate, M., Forster, D., ... Beneyto-Ferre, J. (2009). Design and methodology for evaluating aerodynamic characteristics of sports textiles. *Sports Technology*, 2(3), 81–86.
- Fédération Internationale des Sociétés d'Avion. (2014). FISA rule book. Retrieved January 11, 2016, from http://www.worldrowing.com/mm/Document/General/General/11/28/66/FISARulebookENupdateapril2014completeperlink_English.pdf
- Ho, C. and Au, Y. 2016. Development of functional racing singlet for professional rowers, *International journal of fashion design, technology and education*, 10(2), 137-145. <https://doi.org/10.1080/17543266.2016.1221144>
- International Olympic Committee. (2015). Rowing: History of rowing at the Olympic Games. Retrieved January 11, 2016, from http://www.olympic.org/Assets/OSC%20Section/pdf/QR_sports_summer/Sports_olympiques_aviron%20_eng.pdf
- Kim, D. E., & LaBat, K. (2010). Design process for developing a liquid cooling garment hood. *Ergonomics*, 53 (6), 818–828.
- Krueger, R. A., & Casey, M. A. (2009). *Focus groups: A practical guide for applied research* (4th ed.). Thousand Oaks, CA: Sage.
- Kyle, C. R., Brownlie, L. W., Harber, E., MacDonald, R., & Norstrom, M. (2004). The Nike Swift Spin cycling project: Reducing the aerodynamic drag of bicycle racing clothing by using zoned fabrics. *The Engineering of Sport*, 5(1), 118–124.

References

- LaBat, K. L., & Sokolowski, S. L. (1999). A three-stage design process applied to an industry-university textile product design project. *Clothing and Textiles Research Journal*, 17 (1), 11–20.
- Moria, H., Chowdhury, H., Alam, F., Subic, A., Smits, A. J., Jassim, R., ... Bajaba, N. S. (2010). Contribution of swimsuits to swimmer's performance. *Procedia Engineering*, 2 (2), 2505–2510.
- Nilsen, T.S. (2009). Basic rowing technique. Fédération Internationale des Sociétés d'Aviron. Retrieved February 20,2016, from http://www.worldrowing.com/mm//Document/General/General/10/87/40/Chapter_3_-_Basic_Rowing_Te_English.pdf
- Olympic Council of Asia. (n.d.). Rowing. Retrieved January 13, 2016, from <http://www.ocasia.org/Sports/SportsT.aspx?maOtyf6W8hZXhtRtiudAsw==>
- Singha, K. (2012). Analysis of spandex/cotton elastomeric properties: Spinning and applications. *Analysis*, 2(2), 11–16.
- Smith, T., & Hopkins, W. (2012). Measures of rowing performance. *Sports Medicine*, 42(4), 343–358.
- Soper, C., & Hume, P. A. (2004). Rowing. *Sports Biomechanics*, 3(2), 237–248.

Declaration

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