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ScienceDirect

Procedia Engineering 147 (2016) 896 – 900

Procedia Engineering

www.elsevier.com/locate/procedia

11th conference of the International Sports Engineering Association, ISEA 2016

The ISEA Winterschool in Sports Engineering: 5 years of education and team building experiences

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Abstract

Aim of the work is to present the ISEA Winterschool experience, spanning over the last 5 years. From 2011 to 2015, 150 students coming from several countries of the world joined the Winterschool in San Vito di Cadore, Italy, spending five days of intense teaching, testing and analysis activities under the guidance of 11 university professors experts in the field of winter sports. The support of about 25 tutors and the presence of a number of industry representative allowed the community to grow in the knowledge of Wintersports engineering and to build and reinforce friendly collaborations. This fostered the exchange of knowledges, stimulated joint projects and student exchanges over the years, that will last as positive results of the experience.

Peer-review under responsibility of the organizing committee of ISEA 2016

Keywords:

1.Introduction

The International Sports Engineering Association (ISEA) is the association of engineers interested to sports technology: among its fundamental aims, there is the educational effort, oriented to give to future Sports Engineers the widest and richest opportunity to learn, apply and develop the engineering approach applied to the sport practitioners and equipments [1].

Sports Engineering is a relatively new discipline that is knowing a growing trend throughout the word for its ability to combine the engineering approach, mathematically and methodologically well sound, with passion for sports, as a growing demand of health and wellbeing. The wide field of engineering finds lots of applications in the study of all aspects of sport, from biomechanics and sensors to equipment and garment, from training and prevention to aerodynamics and energetics. Material Engineering, mechanics, electronics, aerodynamics, bioengineering and almost all fields of engineering are challenged by the innumerable disciplines and aspects of Sports: some books, specifically developed and oriented to such studies [2,3] are recommended to students to appreciate how the field requires a multidisciplinary approach.

As an applied science, Engineering demands to combine a theoretical background with a practical application: the laboratory then has to be not only a workshop but it can become a track, a field, a channel or a slope, depending on the discipline.

2.The ISEA Winterschool format

Following the experience of ISEA Summer schools, hold early on in Italy and Chemnitz, on 2011 we proposed to ISEA board the organization of the first ISEA Winterschool, to be held in San Vito di Cadore, Italy, with the twinned organization of the

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Peer-review under responsibility of the organizing committee of ISEA 2016
doi:10.1016/j.proeng.2016.06.282

University of Padova and Technical University of Chemnitz. The authors of this paper, together with Dr. Martin Strangwood (UK) took part to that first experience: we hosted 25 students coming from 6 different countries from around the word. In addition, 8 tutors were involved for the organization of practical sessions and some industry representatives came to support the event (Fig. 2.f). The students were divided into 5 groups of 5-6 students, following the intentional criterion of mixing the student nationality and background to foster the exchange of experiences and new collaborative relations. To each group, a research question was assigned to be addressed in the four following days.

A key factor for the success of experience was the logistic support from the University of Padova, Department of Forestry Sciences: the lectures and practical sessions took place at the Center for Forestry Researches in San Vito di Cadore, equipped with a lecture hall for 55 people, a computer room with 10 PCs, several laboratory rooms and a small flat for the accommodation of 7 tutors (PhD or MSc students experienced with the instrumentations, not giving lectures) in self catering (Fig. 1). This, together with the voluntary contribution of teachers, the coverage of teachers travel costs by the University of Padova and some support from ISEA association allowed to reduce the registration cost for students, covering only their accommodation at the Hotel Park des Dolomites and Hotel Dolomiti, located at walking distance from the University Centre.

(a) (b) (c)

Fig.1. the Center for Forestry Researches, University of Padova, San Vito di Cadore, Italy a) The Center from outside b) Main Lecture hall. c) Computer room.

The format of the event was the combination of *Theoretical lectures*, read by professors active in the field of Sports Engineering, *technical sessions*, with the application of sensors to wintersport equipments and data acquisition systems for a "hands-on" approach, and *field test sessions*, when equipments and data collection systems prepared by students were be used in the slopes (Table 2).

The time span of the Winterschool was typically of 5 days: field tests were performed on the first two days, whereas data collection was carried out until the afternoon of the fourth day, when each group was asked to present their assigned project. Teachers and industry representative acted as a jury to rank the groups and award the Winterschool best group presentation.

Table 1. Program of the 4th ISEA Winterschool, held in San Vito di Cadore, Italy in February 2014.

	SUNDAY Feb 23	MONDAY Feb 24	TUESDAY Feb 25	WEDNESDAY Feb 26	THURSDAY Feb 27	FRIDAY Feb 28
		7.20 – 7.50 Breakfast 7.50 – 8.10 Briefing	7.20 – 7.50 Breakfast 7.50 – 8.10 Briefing	7.30 – 8.00 Breakfast	7.30 – 8.00 Breakfast	8.00 Breakfast
MORNING	Arrival to location *(Skiing possible..)*	**8.30 Ski session 1 on slopes** 1. Ski/Snowboard Subjective Evaluation 2. Check of Instrumentations 3. Preparation of snow slopes	**8.30 Test session 1 on slopes** (Groups) 1. Ski 1 2. Ski 2 3. Ski 3 4. Ski boots 1 5. Ski boots 2 6. Snowboard 1 7. Snowboard 2	**9.00 Teaching Session 2** ▪ *4 Biomechanical Issues in Wintersports (Senner)* ▪ *5 Ski-boot Evaluation (Colonna&Petrone)* ▪ *6 Boot Sole Materials (Vibram)* **11.00 Field Data analysis** (groups) *Analysis of data*	**9.00 Group Work:** ***Preparation of the Group Project Results*** ***11.00 MEETING of Teachers WITH INDUSTRY***	**Ski & Snowboard slalom "competition"** **Free skiing**
AFTERNOON	WELCOME & REGISTRATION	**16.00 Teaching Session 1** ▪ *1 Biomechanics and Sensors (Petrone & Schwanitz)* ▪ *2 Field Motion Capture and GPS (Supej&Gilgien)* ▪ *3 Airbag D-air (Dainese)* **18.00 Group task definition** ▪ *Grouping of students* ▪ *Preparation of Field Tests*	**16.00** **Field Data analysis** (groups) *Analysis of collected data*	**12.30-13.30 LUNCH** **14.00 Group Work:** ***Preparation of the Group Project Results*** **18.30 Teaching Session 3** ▪ *7 Modeling in Wintersports Biomechanics (Kersting&Senner)*	**12.30-13.30 LUNCH** **15.00** **Conclusive Workshop:** ***Presentation and Discussion of Group Project Results with Industry representatives*** ***Final Panel***	***Free skiing*** DEPARTURES
	19.30 – 20.30 Dinner	▪ 19.30 – 20.30 Dinner	19.30 – 20.30 Dinner	19.30 – 20.30 Dinner	19.30 – 20.30 Dinner	
EVE	21.00 Winterschool Introduction **Group task definition** *Presentation of Group Projects*	**20.45 Group meeting** ▪ *Preparation of Field Tests*	Social evening San Vito by Night	Social evening Cortina by Night	FAREWELL PARTY	

3.The Engineering Contents

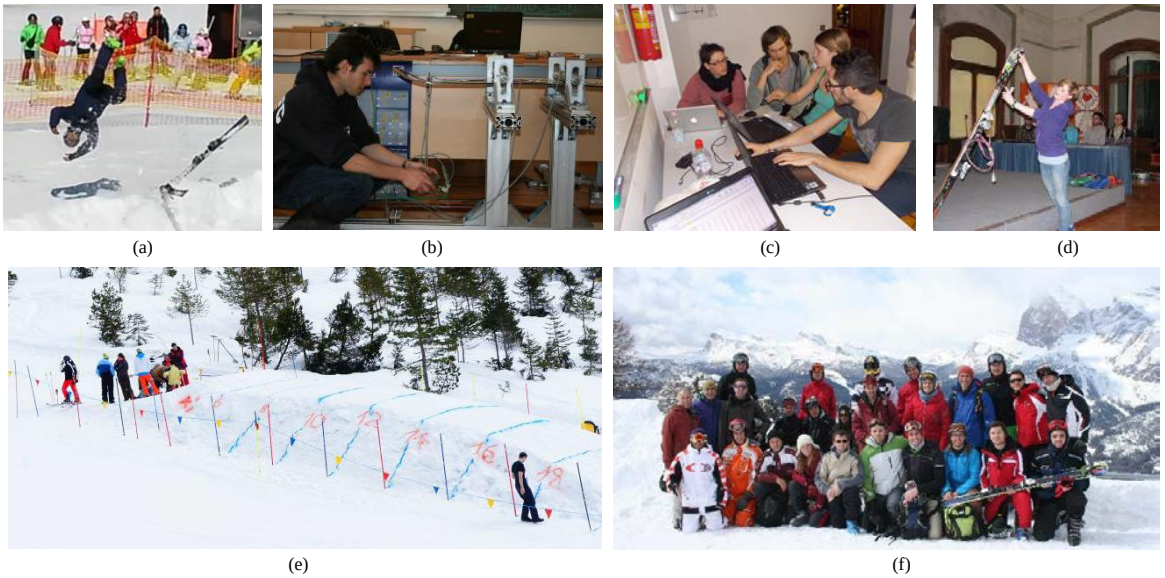
Over the years, Winterschool topics changed, from measurement systems to research methods, equipment performance, biomechanics and wintersport safety issues: as well, a number of colleagues joined the team of teachers, bringing their expertise and instrumentation to perform the tests. Martin Strangwood (UK), Mont Hubbard (USA), James Mc Neal (USA), Andrey Koptyug (SWE), Alessandro Pezzoli (IT), Uwe Kersting (DK), Martino Colonna (IT), Matej Supej (SLO), Matthias Gilgien (NOR), Stephen Thraten (AUS). Each teacher was asked to give a lecture to the students, based on his expertise: topics spanned from Research Methods in Wintersports to Snow Friction, from Wintersports Materials to Biomechanical modelling, from Jump safe design to Boot materials and flexibility, from GNSS systems to Ambient and Weather effects on performance.

Also, a growing number of companies supported the event bringing their winter sports materials (Nordica, Tecnica, Blizzard, Dal Bello, Dainese, Vibram) or their instrumentations (Xsens, HBM, IMC, Kyowa, National Instruments, Moticon).

The numbers of this experience are summarized in Table 2, from which the variety of countries and industry involvement can be appreciated. Table 3 reports the Group Projects that were assigned to the students over the 5 years, with the mention of the University or Company supervising the group and the type of instrumentation and data logger available to students.

Table 2. Participants to the 5 ISEA Winterschool held in San Vito di Cadore, Italy, from 2011 to 2015.

	2011	**2012**	**2013**	**2014**	**2015**
Teachers	4	3	7	6	10
Countries	I (1), D (2), UK (1)	I (1), D (2)	I (2), D (2), USA (2), SWE.	I (2), D (1), DK, SLO, NOR	I (2), D (2), USA (2), DK, SLO, SWE, AUS
Students (M / F)	26 (20 / 6)	35 (23 / 12)	28 (25 /3)	25 (16/ 9)	36 (23 / 13)
Countries	I (14), D (8), LV (2), USA (1), JAP (1)	I (17), D (11), UK (4), USA (1), CAN (1)	I (8), D (9), UK (7), SWE (2), NL (1), JAP (1)	I (6), D (12), UK (5), FR (1), CAN (1)	I (9), D (12), UK (8), DK (2), SWE (2), AUS (1), NL (1), POL (1)
Tutors	8	8	10	9	10
Industry Experts	4	3	3	5	6
Sponsors	TU Chemnitz, UNIPD, ISEA, Nordica, Blizzard, HBM, XSENS	UNIPD, TU Chemnitz, ISEA, Nordica, Blizzard, IMC	UNIPD, ISEA, Nordica, Blizzard, IMC	UNIPD, ISEA, Nordica, Blizzard, Vibram, Dal Bello, Nat. Instruments, Dainese	UNIPD, ISEA, ISSS, Nordica, Blizzard, Dynafit, Nat. Instr; DolomitiCert, Motorialab
Staff	1	2	2	1	1



(a) (b) (c) (d) (e) (f)

Fig.2. Pictures from 2011-2015 ISEA Winterschools. a) Field tests sessions (2015-Dummy forward falls). b) Laboratory Tests (2012-Snowboard flexion) c) Data Analysis (2014-Hyper flexible boot). d) Final Project presentation (2013-Ski shovel torsion). e) Constant EFH jump built at the Winterschool. f) 2011 Group Picture at Cortina d'Ampezzo.

4.The Results

The results of this experience can be analysed by different viewpoints: the educational and academic point of view, the scientific point of view, the ISEA association point of view, the social point of view. From the educational point of view, it can be seen as a total number of 150 students from 13 countries took part to the school. Several of them carried on a master project or a PhD focusing on Sports Engineering afterwards, and many decided to focus on wintersports.

Table 3. List of Group Projects assigned at the ISEA Winterschool held in San Vito di Cadore, Italy, from 2011 to 2015.

2011	***"Experimental methods in Wintersports"***		
GROUP (5)	TOPIC	SUPERVISION	INSTRUMENTATION
SKI -1	1- Field motion capture with Xsens	Xsens –NL	Xsens suite + Video
SKI -2	2- Ski Vibration data collection	Tech. Univ. Chemnitz	Accelerometers + IMC
SKI – 3	3- Ski bindings force data collection	Tech. Univ. Munchen	Dynamometric Ski Bindings
SKI – 4	4 – EMG data collection on skis	Univ. Padova	EMG + Biometrics + BTS
SNOW -1	5 – EMG data collection on snowboards	Univ. Padova	EMG + Biometrics + Somat
2012	***"Wintersports equipment evaluation for safety & performance"***		
GROUP (6)	TOPIC	SUPERVISION	INSTRUMENTATION
SKI -1	Effect of Nordica EDT on ski shovel torsion/vibrations	Univ. Padova	Strain Gauged skis + Somat
SKI - 2	Evaluate Ski orientation angles and vibrations in Slalom skiing	Tech. Univ. Chemnitz	6 Accelerometers + IMC + GPS
SKI – 3	Effect of ski length, skier and turn radius on ground reaction forces [4]	Tech. Univ. Munchen	Dynamometric Ski Bindings
BOOTS – 1	Collect and compare the Flexural behavior of boots in Lab and Field [5]	Univ. Padova	Biometrics + BTS
SNOW -1	Compare the behaviour of a traditional board and an innovative Silbaerg board	Univ. Padova & Tech. Univ. Chemnitz	Novel Insoles + Silbaerg boards
SNOW -2	Effect of right / left stance on flexural / torsional strain on a board during slalom	Univ. Padova + IMC	Strain Gauged board + Somat
2013	***"Research methods in Wintersports"***		
GROUP (7)	TOPIC	SUPERVISION	INSTRUMENTATION
SKI -1	Effect of different Nordica EDT construction on ski torsion/vibrations	Univ. Padova	Strain Gauged skis + Somat
SKI - 2	Evaluate Canting-angles in Slalom-skiing	Tech. Univ. Chemnitz	6 Accelerometers + IMC + GPS
SKI – 3	Effect of Twin Carver devices in slalom turns	Tech. Univ. Munchen	Dynamometric Ski Bindings
SKI – 4	Compare Shovel vibrations in Lab and Field, with active damping system UVO	Tech. Univ. Chemnitz	6 Accelerometers + IMC + GPS
BOOTS – 1	Effect of buckle closure on thermal comfort and boot flexural behaviour	Univ. Padova & Univ. Bologna	Biometrics + I-button + BTS
SNOW -1	Build a constant EFH jump and measure the experimental EFH [6]	Universities of Davis, Padova, Mid Sweden	2 Triaxial Accelerometers + constant EFH Jump
SNOW -2	Collect the flexural / torsional behaviuor of a strain gauged board during jumps	Univ. Padova + IMC	Strain Gauged board + Somat
2014	***"Wintersports and Biomechanics"***		
GROUP (7)	TOPIC	SUPERVISION	INSTRUMENTATION
SKI -1	Trunk kinematics of skiers with different skills	Univ. Padova	Humotion Gyro and Acceler.
SKI -2	Full body 3D kinematics of skiers in slalom [8]	Univ. Lljubljana	Xsens suite
SKI - 3	The effect of physical strain on body microclimate in typical skiing cycles	Tech. Univ. Munich	Spyrometer + thermocouples + humidity sensors
BOOTS – 1	The effect of BOOT flex index on in-field flexural boot behavior	Univ. Padova & Univ. Bologna	Biometrics + I-button + BTS
BOOTS – 2	The effect of a hyper flexible boot on the ankle angle and muscle behavior [7]	Univ. Alborg	EMG + goniometer + LView
SNOW -1	Effect of different padding on boot vibrations in snowboarding.	Univ. Padova & Vibram	Accelerometers + Somat
SNOW -2	Compare EMG during skiing and stationary balance training device	Tech. Univ. Chemnitz	EMG + Moticon insoles

(..continues..)

Table 3 (continued). List of Group Projects assigned at the ISEA Winterschool held in San Vito di Cadore, Italy, from 2011 to 2015.

2015 GROUP (9)	***"Safety Issues in Wintersports"*** TOPIC	SUPERVISION	INSTRUMENTATION
SNOW -1	Constant EFH jump profile construction and measurements [6]	Colorado & UC Davis	Digital levels and meters
SNOW -2	Jump kinematics collection and analysis	University of Padova & Univ. of Washington	Two triaxial accelerometers + videos.
SNOW -3	3D kinematics and GRF synchro collection [6]	Univ. of Ljubljana & Alborg	Xsens suite + Dynamometric snowboard bindings.
SKI -1	Correlation between Sole Pressure and Binding Loads [4]	Tech. Univ. Munich	Dynamometric Ski Bindings + Moticon insoles
SKI – 2	Synchronous data collection of field based system cameras and sensors	Univ. Padova & MotoriaLab	Exel sensors + HIFIS system MotoriaLab
SKI -3	Full scale motion capture of forward ski falls against an obstacle with ATD	Univ. Padova & DolomitiCert	Hybrid III DUMMY + High speed video + Humotion sensors.
BOOT - 1	Comparison of two Dynafit skiboots	Univ. Padova & Mid Sweden & Dynafit	Biometrics + Moticon + thermo-pressure sensors
GARMENT-1	Comparison of Skiwear and Skin Stretch in cross country analysis	Tech. Univ. Munich	Skin & fabric Strain sensors
GARMENT-2	Thermoregulation and dehydration in winter snow-shoe sports	Tech. Univ. Munich	Thermocouples + humidity sensors

Despite the fact that it was not formally quantified with a formalized questionnaire, the appreciation from all the participants and their enthusiasm was expressed to all the teachers through the communication following the events, as well by spreading the voice of a good experience to suggest to their course colleagues.

We experienced directly and have been reported by international colleagues (without formal records about this) that the students that took part to such a demanding "crash course" in field application of experimental methods, behaved brilliantly in the university courses following the Winterschool, sharing with other students their expertise. Several Erasmus agreements were set and many student exchanges took place between Universities involved in the collaboration.

From the scientific point of view, most of the group projects acted as pilot tests for the researchers that successively completed the data analysis, performed confirmatory tests and published results as research or conference papers [5]. Scientific collaborations between teachers lead to common test sessions, joint funding programs and further publications.

ISEA association gained in student memberships, international visibility and industry appreciation and credibility. From the social point of view, the ISEA Winterschool gave birth to a large number of friendly relations spanning throughout the world, still lasting from the first edition.

The experience of the five years also allowed to identify some challenges for the organisation of a successful Winterschool experience: a) planning ahead the group activities so that instrumentation will perform reliably and tasks will be clear in the groups; b) focus mainly on the experimental projects, reduce the number of theoretical lectures, only relevant to the subjects; c) prepare a sustainable program and circulate it to all attendants in advance; d) set strong collaborations with the local agencies (resort, athletes, ski rentals) so that logistics and support shall not be an issue; e) involve the appropriate number of staff for the communication and international relationships with teachers, tutors students and industry representatives.

5.Discussion and Conclusions

We believe that the experience can be extended to other countries and other fields of sports, such as athletics, cycling or ball games, with the important result of building the sports engineers and scientists community towards a wide network of collaborative relations.

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