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Project Fit & Sail

Interim report on the status of the project, September 2007

Contents

1. Preface and thanks

In cooperation with the Bundesverband Wassersportwirtschaft e.V. (BVWW – German Marine Federation) in Cologne, the Institut für Sport und Sportwissenschaften (ISS – Institute for Sport and Sport Science) at the University of Kiel and the Institut für Boots-Tourismus (IBoaT – Institute for Boat Tourism) in Bonn, in 2005 the research project "Fit & Sail" was initiated to examine the physical and mental effects of cruise sailing on older people. The project is supported by the French "Connect to Sailing task force" of the Federation Française de Voile (FFVoile) in Paris.

The project has the following objectives:

1. Observation, data collection and evaluation by sports doctors of physical and mental exertion in male and female test persons of differing ages (giving particular consideration to the 60+ age group) during various typical activities on board

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cruise sailing boats under sail and under motor power. Evaluation of the results with regard to age- and sex-related exertion levels and their interpretation in terms of health, sport science aspects and training know-how.

2. Comparative, experimental testing of innovative structural measures and items of equipment and their ergonomic options for reducing exertion peaks, for lowering use inhibitions and for improving the handling and safe operation of cruise sailing boats, particularly by older male and female sailors.

3. Summary of the results to produce recommendations
   - on the one hand for active and potential sailors for health-related aspects of cruise sailing,
   - on the other hand for purchasers, manufacturers and outfitters of cruise sailing boats for health- and exertion-optimized construction and technical options in the design and equipment of boats.

The project was coordinated by Dr. Wolf-Dieter Mell, Institute for Boat Tourism (IBoaT).

The concept of the project was presented at the BOOT 2006 boat show in Düsseldorf, where it was received with great interest and offers of support.

By the end of 2006, sponsors had provided the following for the project "Fit & Sail":

- A cruise sailing boat Hanse 341 from Hanse AG Greifswald for sports medicine studies,
- A small cabin cruiser Neptun 22 from Institute for Boat Tourism Bonn for pilot studies and technical tests,
- Mobile equipment for Hanse 341 (from life jackets, ropes and fenders through to sea charts and crockery) from A.W. Niemeyer GmbH Hamburg,
- Extensive services from ancora Marina Neustadt in Holstein for the necessary conversion and maintenance work,
- Bow thruster and electronic engine remote control from Volvo Penta Central Europe GmbH Kiel for production and test of prototypes in the "ComfoDrive" system (see below),
- Funds from the Donation Programme of the International Marine Certification Institute (IMCI) Brussels as a contribution to covering material and personnel costs,
- Personnel and materials provided by the three project partners in the context of the project.

Many thanks to all sponsors for their generous support to the "Fit & Sail" project with materials, services or funds.

2. Initial situation

Since about 2004, the water sport branch has been watchfully observing the following data and development trends with increasing concern:

1. Statistics regarding the age of people owning larger yachts with water moorings (in German marinas) show a clear predominance of the 50+ age group (see Fig. 1). About one third of the boats belong to owners who are older than 60.

Age group	Percentage		Number of boats
up to 35	8 %	37 %	10,480
36-50	29 %		37,990
51-55	17 %	30 %	22,270
56-60	13 %		17,030
61-65	15 %	33 %	19,650
over 65	18 %		23,580
total	100 %		131,000

Fig. 1: Boat owners in Germany according to age group (Source: Surveys at marinas, expert interviews)

   At the moment it is not at all clear whether this age spread is a late result of the cruise sailing boom of the 1970s, or whether it results from mechanisms with longer term stability (income distribution, cost structure of the boats, leisure patterns, etc.).

2. Reports from the marinas and interviews with older former boat owners indicate that owners of cruise sailing boats start to give up their boats and sailing on an active level as from an age of about 70, as it is "getting too tiring" for them. The interviews also indicate that in many cases, the female partners of the skippers have a major influence on the decisions, as older women in particular no longer feel capable of coping with the demands made on board.

3. General population development indicates that the number of gainfully employed aged between 40 and 60 will decrease by almost one third in the next 40 years, while the number of pensioners aged over 60 will clearly increase in the same period.

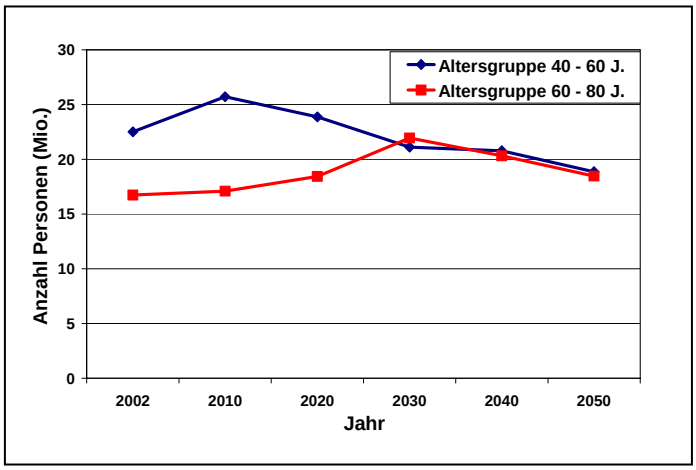

Fig. 2: Population development in Germany (Source: Federal Statistics Office)

4. Sport science studies of how the physical capabilities depend on age show on the one hand a general decline in physical strength of around 10% p.a. from the age of 30 to 40, while on the other hand women have around one third less physical strength than men (see Fig. 3).
The diagram clearly shows that the physical tasks on board (e.g. setting the sails, hauling the sheets, hauling the anchor) which are gradually "too tiring" for a 70-year old man are frequently already too much for a 40-year old woman.

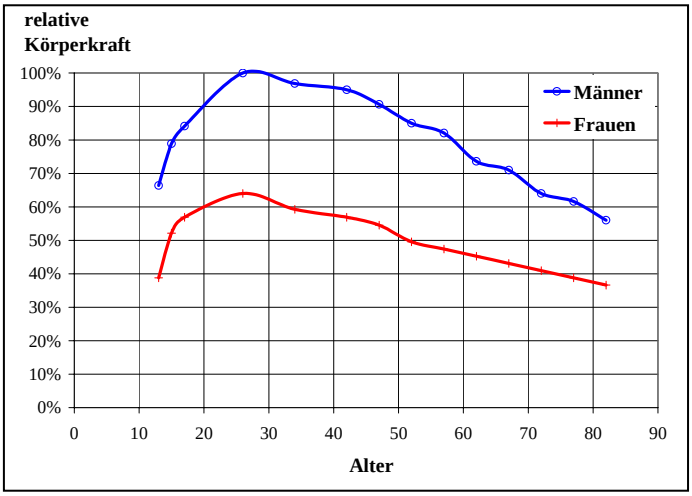

Fig. 3: Mean age development related to upper body and arm strength in men and women (Source: IBoaT derived from the requirements for the German sport award)

5. Gerontologists indicate that in the years ahead, progress in medicine and medical technology will probably continue to improve the average health of older people, so that an ever larger share will achieve a high to very high age in appropriate health. These "healthy senior citizens" will want to live their retirement years more intensively and more actively than former generations.

In summer 2005, IBoaT carried out the first (worldwide) study for long-term measurement of cardiovascular exertion during cruise sailing with a 65-year old test person during a sailing trip. The study and its results were described in detail in

IBoaT-Report 3.1:
Wolf-Dieter Mell, Study: long-term measurement of the cardiovascular exertion during cruise sailing and everyday activities, September 2005

The main results were as follows:

Test person data:

maximum heart rate HF_{max} [1)]	approx. 169 bpm
Exertion zones (modified Borg scale):	
slightly tiring B1 (50-60% HF_{max})	84 - 101 bpm
somewhat tiring B2 (60-70% HF_{max})	101 - 118 bpm
tiring B3 (70-80% HF_{max})	118 - 135 bpm
very tiring B4 (80-90% HF_{max})	135 - 152 bpm

1) The maximum heart rate HF_{max} was estimated with the "Ownindex" test of the running computer POLAR S625X.

Exertion data of important activity groups:

Activity group	Mean heart rate (bpm)	Range (bpm)	Exertion zone
"sails, ropes, sheets"	aprox. 110	100 - 130	B2 - B3
"manoeuvring in confined space"	approx. 115	100 - 135	B2 - B3
"long strokes"	approx. 85	75 - 100	B1

with the activity groups defined as follows:

- "Sails, sheets, ropes"
  summarising the foredeck hand's activities setting the sail, recovering the sail and crossing
- "Manoeuvring in confined space"
  summarising the helmsman's activities under motor power for casting off, mooring in a box and passing through locks,

- "Long strokes"
  summarising the foredeck hand's activities sailing broad reach, sailing close to the wind and the helmsman's activities under motor power which has a very similar exertion level as steering a boat under a long stroke.

An age projection based on a maximum heart rate which decreases with age results in the following exertion rates that rise with increasing age for these three groups of activities (see Figs. 4, 5, 6):

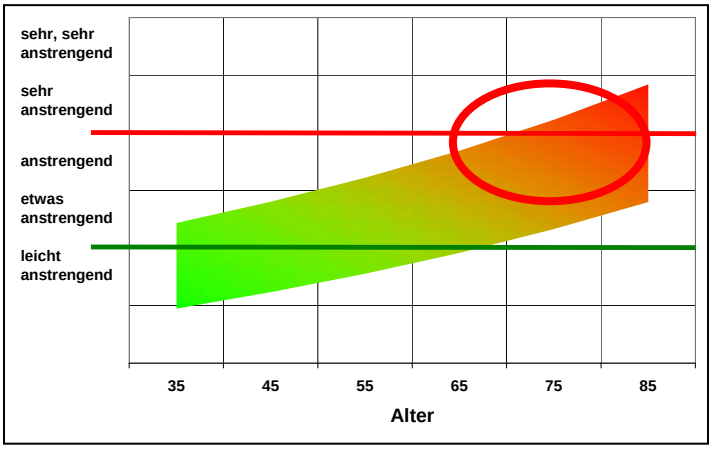

Fig. 4: Age projection for the activity group sails, sheets, ropes

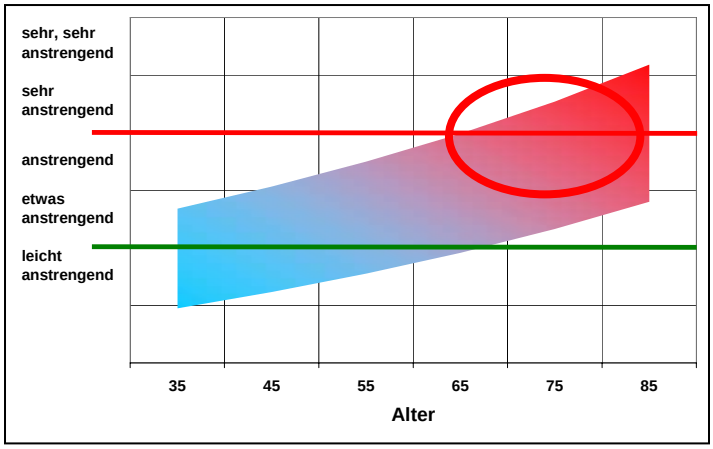

Fig. 5: Age projection for the activity group manoeuvring in confined space

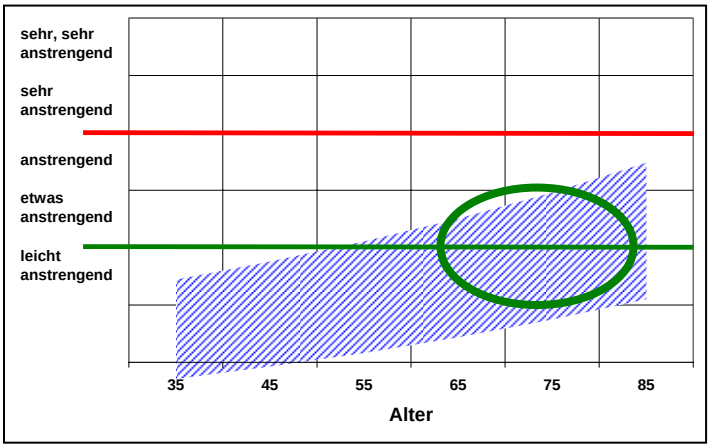

Fig. 6: Age projection for the activity group long strokes

The data and projections produce the following information:

1. For the most part, it is physically tiring for a 65-year old sailor to handle the sails, ropes and sheets; these activities will probably be very tiring for him at the latest on reaching 75 years.
2. Manoeuvring a cruise sailing boat under motor power in harbours and locks causes considerable stress in older sailors (particularly under poor weather conditions) with high, tiring cardiovascular exertion. The projection indicates that this stress is felt to be very tiring with increasing age.
3. Sailing or travelling under motor power with long strokes generates a slightly to somewhat tiring exertion level as a result of the remaining activities during these phases. For the 60+ age group, this exertion is on about the same level as for example light, active walking and can therefore be interpreted as healthy training.

3. Project aims

In order to limit the framework of the project, those involved in "Fit & Sail" decided to concentrate on the following topics:

- The studies focus on older male and female sailors in the 60+ age range on cruise sailing yachts.
  It is presumed that a series of sub-problems will be dealt with as relevant for older water sportsmen and –women on motor boats or dinghies.

- The basic questions are:

  a) Why do older sailors give up cruise sailing from an age of around 70 years, although they enjoy sailing, are adequately healthy and physically fit and although they subsequently continue to drive cars safely without any problems?

  b) What can the nautical branch do to keep potentially older "drop-outs" on their yachts for a further 5 to 10 years, i.e. until an age of 70 – 80 years, permitting them enjoyable, pleasant sailing?

  c) Consideration should also be given to how other customer segments (e.g. younger sailors, less experienced sailors, family crews, etc.) would probably react to corresponding offers and products?

- The IBoaT study on cardiovascular exertion during cruise sailing and the preliminary considerations resulted in the following three theses:

  1. There are a series of activities and exertions on board cruise sailing yachts which sailors feel to be "unreasonably tiring" with increasing age. If recurrent exertions reach individual limits ("use inhibitions"), then the sailor will refuse to carry out these activities on board.

  2. Manoeuvring conventionally equipped cruise sailing yachts (without bow thrusters) in harbours, locks and other confined spaces creates a high level of potential stress under poor marginal conditions (side wind, current) which is also felt to be "unreasonably tiring" with increasing age. If the stress potential reaches a certain individual level, then the sailor will avoid these activities.

  3. Apart from the high-exertion situations, cruise sailing offers activities and exercise during the long stroke phases with exertion levels similar to light weight and endurance training. It should be possible to verify this level of training by sport medicine methods following sailing trips of an adequate duration, with the sailors in improved condition.

This results in the following work assignments for the first research section of the project:

- Sport medicine methods are to be used to examine:

  a) Which physical capabilities can be expected in older male and female cruise sailors compared to the population on average?

  b) Which procedures and activities on board a larger cruise sailing yacht cause particular exertion levels, and how high are these levels?

  c) Is it possible to verify healthy training effects of cruise sailing trips in sport medicine terms?

These questions were assigned to the Institute for Sport and Sport Science at the University of Kiel.

- Technical solutions are to be examined to make it easier and safer to manoeuvre sailing yachts under motor power. Prototypes are to be produced of suitable concepts with subsequent testing.

  This sub-project with the name "ComfoDrive" was assigned to the Institute for Boat Tourism in Bonn.

- Another aspect consists of searching for methods to reduce the fundamental strength required to handle the halyards and sheets. This will focus on solutions such as motor winches for both hauling and slackening the rigging.

  This sub-project has been postponed for the time being for capacity reasons.

4. Research phase 2007

In preparation of a planned field study on the influence of cruise sailing on physical capabilities, in summer 2006 the Institute for Boat Tourism carried out an extensive study together with the ISS of Kiel University. On the one hand, this compared special training procedures "on land" with the physical changes to the body after a cruise sailing trip lasting several weeks; on the other hand, the measurement and diagnosis problems and demands made by this kind of study were documented and evaluated.

The results were summarised and published in two IBoat reports:

IBoaT report 3.2:
Wolf-Dieter Mell, Pilot study: Comparison of the effects of vibration training and cruise sailing on jumping capability, December 2006

IBoaT report 3.3:
Burkhard Weisser, Wolf-Dieter Mell, Methodical indications for diagnosing changes in physical capabilities of older sailors following cruise sailing trips, March 2007

4.1. Sports medicine studies

The Hanse 341 "Fit & Sail" provided by Hanse AG for the sports medicine studies was handed over in fully equipped state to the Institute for Sport and Sports Science in Kiel on 8 September 2006.

Following several test trips and initial studies of test persons on board, the boat was brought for winter storage to ancora Marina (Neustadt in Holstein) on 22 October 2005 and brought back to Kiel on 13 May 2007 to continue the studies in the 2007 sailing season.

The test persons for the study were acquired following press reports on the project "Fit & Sail" in regional and national daily newspapers and also in sailing publications.

Up until September 2007, ISS in Kiel studied:

26 test persons in the laboratory,
14 test persons (11 men, 3 women) on board the yacht.

At the same time, 10 crews were obtained to take part in the field study on the influence of cruise sailing on physical capabilities. The corresponding results are not available yet.

The studies on board were subject to considerable influence from the weather in the 2007 season: on the one hand, there was an above average amount of rain on the stipulated test days (Monday in each case), which was occasionally detrimental to the motivation of the test persons. On the other hand, there were usually low winds during the studies so that exertion measurements while handling the sheets and stress studies when manoeuvring under motor power had to be carried out for the main part without aggravating general conditions.

The laboratory tests consist on the one hand in ascertaining the basic physical capability with exercise ergometry. The main results of these measurements with significance for ascertaining the exertion levels on board were:

For the test persons with an average age of 65 years,
mean values on the anaerobic limit were ascertained with a
heart rate of around 130 bpm and an
endurance performance of around 117 watt.

In addition, a series of data on individual coordination ability and upper arm strength (biceps and triceps) was collected for each test person.

Note:
The generation of energy in the human body above the aerobic limit (in our test persons this was at a heart rate from about 100 bpm) results in the production of lactic acid (lactate) which passes into the blood and decomposes. The lactate level in the blood rises with increasing exertion. The lactate decomposition capacity is limited. The anaerobic limit refers to the exertion intensity where there is just still a balance between formation of new lactate and maximum lactate decomposition. Further increases in exertion result in an accumulation of lactate in the blood and in the cells, with a progressive reduction in the ability of the muscle cells to perform. The anaerobic limit is referred to as the highest individual exertion that can be sustained in the long term. It is known from comparison studies with the Borg scale that exertion above the anaerobic limit is felt to be "very tiring".

In order to assess the exertion levels measured with the heart rate, a Borg scale can be used which defines the exertion zones of the subjectively "felt" effort according to the heart rate in relation to the anaerobic limit.

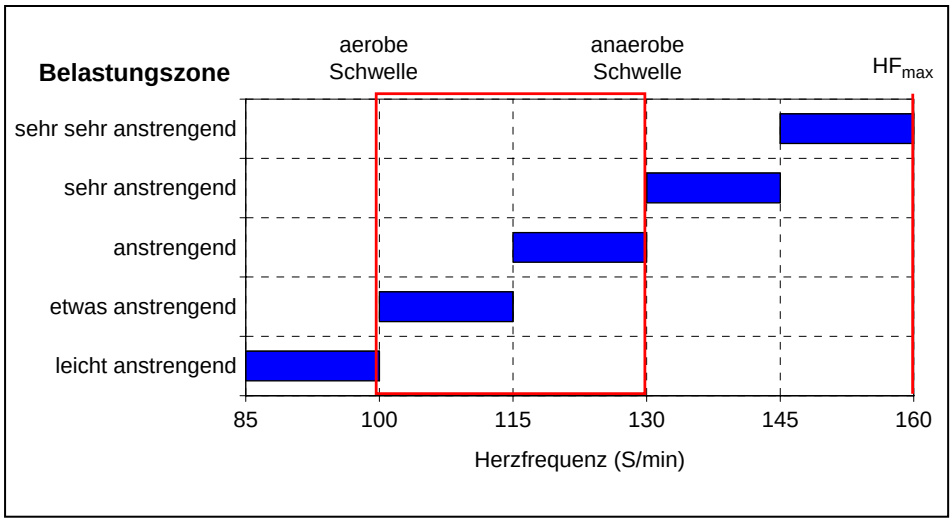

Fig. 7: Mean heart rate exertion zones (Borg scale) for test persons aged on average 65 years

Basically the diagram shows that 65-year old test persons perceive exertion as being tiring from a heart rate of approx. 115 bpm.

For the measurements on board, every test person had to go through a standard programme including the following activities:

casting off from the box under motor power,
setting the mainsail,
setting the foresail,
doing a turn,
doing a jibe,
doing a man overboard manoeuvre,
hauling the mainsail,
mooring in the box

The test person's heart rate and blood pressure were measured continuously throughout the programme, using suitable wireless instruments.

Gaps in the data resulted in isolated cases when certain activities were not carried out with individual test persons, or when the instruments occasionally failed.

The following illustration shows the age spread of the test persons.

Of the 11 men, the youngest was 59 and the oldest 79 years of age; of the three women, the youngest was 52 and the oldest 59 years of age.

Age group	Men	Women
50-54	0	2
55-59	1	1
60-64	2	
65-69	6	
70-74	1	
75-79	1	

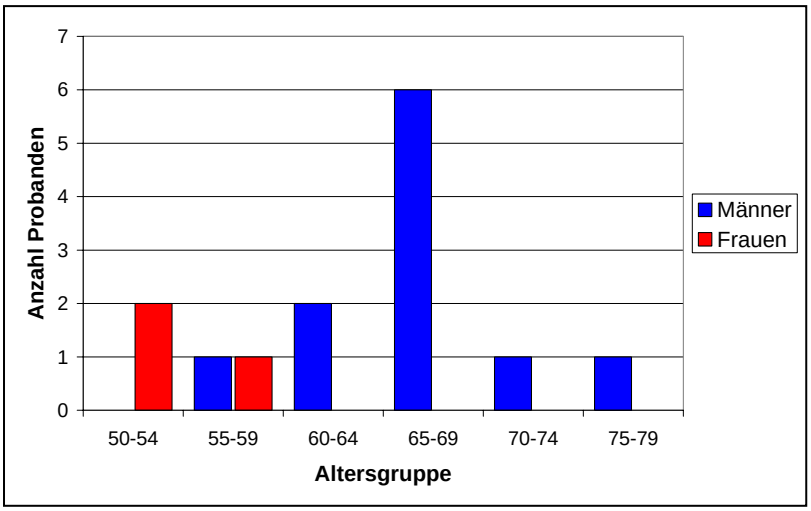

Fig. 8: Age spread of the test persons

A sample group consisting of 11 men and 3 women naturally does not permit any representative statements.

However, as an initial sport medical study of a group of older people on board a cruise sailing ship, it does provide some very interesting information about the type and background of exertion peaks.

The following illustrations concentrate on the results of measuring the heart rate referring to the exertion zones of the Borg scale explained above.

		Type of activity						
Heart rate bpm	**Exertion zone**	**Casting off**	**Setting the mainsail**	**Turn**	**Jibe**	**Man overboard**	**Hauling the mainsail**	**Mooring**
85-99	slight	1	0	3	2	2	1	0
100-114	somewhat tiring	4	0	3	2	1	5	6
115-129	tiring	3	1	3	4	2	1	1
130-144	very tiring	2	2	2	2	4	1	2
145-160	very, very tiring	0	6	0	0	1	0	1
		n=10	n=9	n=11	n=10	n=10	n=8	n=10

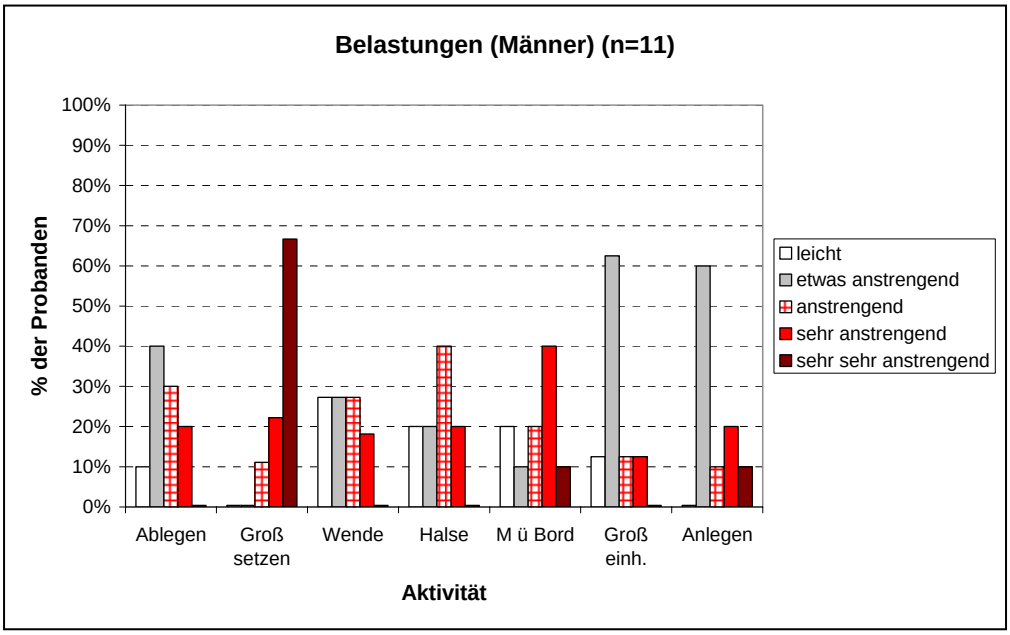

Fig. 9: Exertion from activities on board: Number of men per exertion zone and type of activity

		Type of activity						
Heart rate bpm	**Exertion zone**	**Casting off**	**Heart rate bpm**	**Exertion zone**	**Casting off**	**Heart rate bpm**	**Exertion zone**	**Casting off**
85-99	slight	0	0	1	0	0	0	0
100-114	somewhat tiring	0	0	0	0	1	0	0
115-129	tiring	1	0	0	0	0	0	0
130-144	very tiring	1	0	2	1	1	0	1
145-160	very, very tiring	0	3	0	0	0	0	0
		n=2	n=3	n=3	n=1	n=2	n=0	n=1

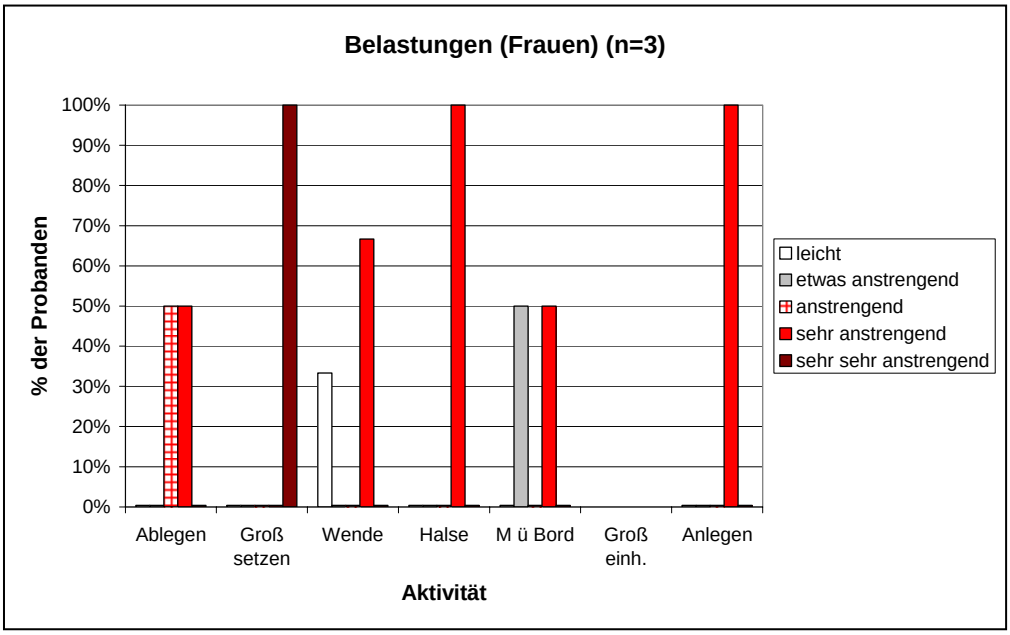

Fig. 10: Exertion from activities on board: Number of women per exertion zone and type of activity

Both tables and diagrams show how many male and female test persons felt which exertion levels during the various activities of the test programme.

The activities can be allocated to two different activity types:

- Foredeck hand's tasks at the halyards and sheets
- Helmsman's tasks

The helmsman tasks of the men (here in particular man overboard and mooring) revealed two effects which will be important for future studies (see following illustration):

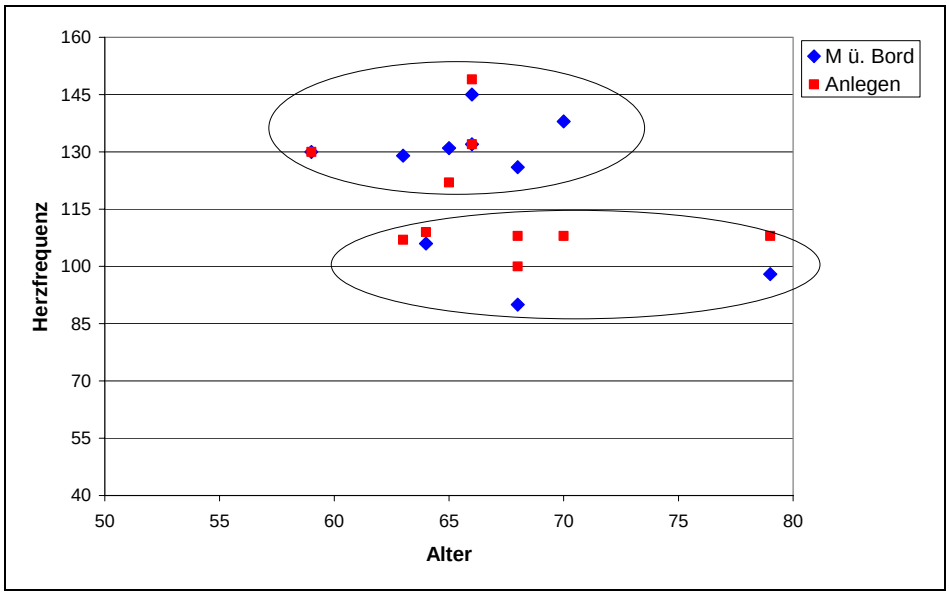

Fig. 11: Dependence of helmsman's activities on age and experience

The heart rate data for these manoeuvres entered over the age of the male test persons show that:

1. The test persons can be divided into two groups, which are about the same in size for this sample group:
   - The group of experienced sailors deals with these standard manoeuvres calmly with heart rates well below 115 bpm.
   - For the group of less experienced sailors, the same manoeuvres are tiring to very tiring with heart rates in part well above the anaerobic limit (130 bpm).
2. The heart rate exertion cannot be said to depend on the test person's age.

   This confirms the thesis that the concrete exertion levels of the sportsmen/women in activities with this sports equipment depend on the one hand on the particularly exerting nature of the activity, possibly on the wind and weather, and on the other hand on the sportsman/woman's experience, but not on his/her age.

   As far as the age projections are concerned (see chapter 2), it follows that an activity measured e.g. with around 120 bpm and classified as "tiring" for a 65 year-old test person could produce approximately the same results for the same test person 10 years earlier or later. But at the age of 55 he/she would probably feel the activity to be only "slightly tiring", compared to "very tiring" at the age of 75 years.

When working with halyards and sheets, it would appear that handling the mainsail on board the research ship constitutes a special case in terms of exertion levels:

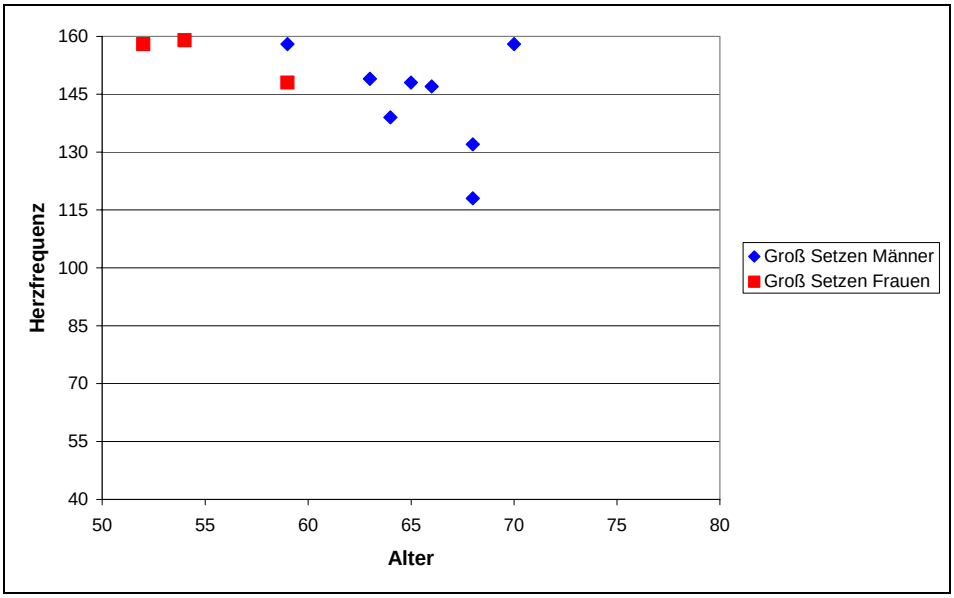

Fig. 12: Physical exertion on setting the mainsail

The diagram showing exertion data over test person age shows on the one hand slight differences in the physical fitness in the test persons and probably also in their experience in dealing with a mainsail.

From these data, it is not possible to say that exertion levels depend on age.

But the main statement is that the exertion felt by the test persons – both men and women – with this activity is clearly in the "very tiring" category, and even for the main part reaching the physical exertion limit of "very, very tiring" (over 145 bpm). In particular the women, who were on average 10 years younger, found this work to be particularly tiring.

It can be presumed that these test persons will not set the mainsail very often under these conditions, and that it is necessary to check the mechanism of these mainsail halyards if older sailors are to be able to set the sails.

The exertion statistics for doing a turn and doing a jibe show that in spite of the low winds prevailing during the tests (around 3 Bft), around half of the test persons found the exertion involved in hauling the sheets to be tiring. These activities and the motions involved must be observed and measured in detail in future studies.

4.2. Sub-project "ComfoDrive"

Since early 2006, the sub-project "ComfoDrive" has looked at technical solutions for making it easier and safer to manoeuvre a sailing yacht under motor power.

The basic ideas and status of the tests in 2007 are described in

> IBoaT report 3.4:
> Wolf-Dieter Mell, Concept ComfoDrive: Dynamic, ergonomic and safety aspects of manoeuvring sailing yachts under motor power, August 2007.

For technical, financial and ergonomic reasons, it was decided to pursue a concept of a main machine supplemented by a bow thruster and a stern thruster, with integrated control by one single 3-axis joystick.

The concept was implemented initially in autumn 2006 as a remote-controlled boat model to gain first experience in the ergonomics of a joystick control.

By the early summer 2007, IBoaT elaborated the specifications for the electronic control module, which was then produced as a prototype by a specialist company with the necessary installations and modifications being carried out in the project's Neptun 22.

In summer 2007, the system prototype was tested as an experiment in a sailing trip lasting several weeks.

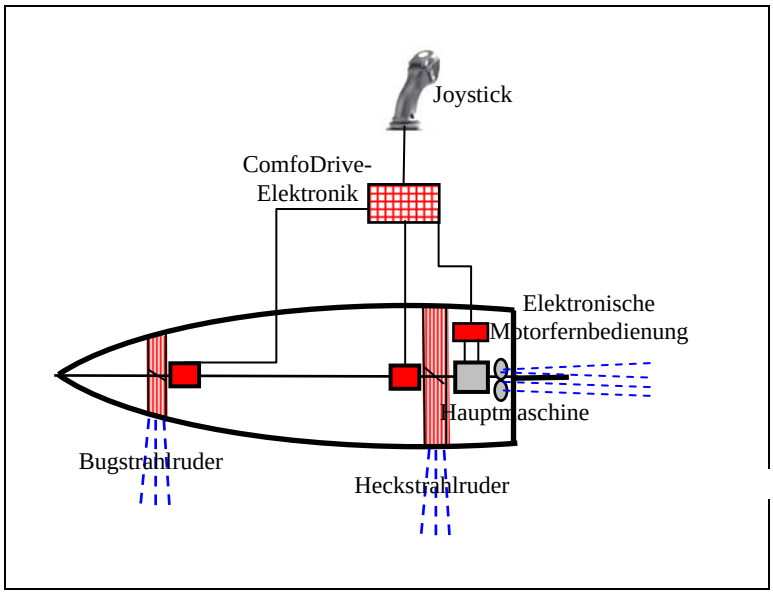

Fig. 13: Technical ComfoDrive concept

Fig. 13 shows the basic technical concept for ComfoDrive. Corresponding implementation requires the following components:

- Main machine with fixed shaft and remote control for transmission and accelerator with Bowden cables. The mechanical remote control is replaced by an electronic remote control whose control interface – a potentiometer in the gearshift – is activated in future by the ComfoDrive electronic module.
- An electric bow thruster and an electric stern thruster whose buttons in future will be activated by the ComfoDrive electronic module.
- A 3-axis joystick with potentiometer sensors and the following movement axes:
  tilting forwards/backwards (y-axis)
  tilting right/left (x-axis),
  turning the joystick button right/left (z-axis)
  for controlling the corresponding "intuitive" movements of the boat (forwards/backwards, to the side, rotation), i.e. by the rudder fixed midships.
- The ComfoDrive electronic module which converts the joystick positions into corresponding actuation signals for the motors, with synchronized actuation of the thrusters. This technology can be used among others for "quasi linear" actuation of the individual thrusters with variable thrust, adapting the initially differing torques of the bow and stern thrusters to permit neat transverse movement of the boat without any additional turning.

The aim of this concept is to be able to control the movement of the boat safely in all directions as well as bow bearing at any time and under difficult conditions (e.g. side wind or current) with low ergonomic effort using only one single joystick.

The system test on the water with the corresponding measurements (including transverse speed, turning movement and leeway from the side wind) indicated that this approach achieved the project aims to the full:

- The boat can be controlled reliably with the joystick under all conditions.
- The crew sees a very great improvement in safety and thus in reducing the stress load on the helmsman, particularly during difficult manoeuvres in a confined space.
- When the joystick is suitably positioned at the helmstand, the intuitive one-hand control of the boat's movements significantly improves the ergonomic aspects of manoeuvring the vessel under motor power.

One particular, important result of the test trips referred to additional ergonomic improvement to the design of the joystick. This includes among others enlarging the tipping angle in the y-axis and modifying the corresponding friction brake. The details are summarised in IBoaT report 3.4.

A second prototype of the ComfoDrive system with the modified joystick will be fitted on board the research ship "Fit & Sail" by early November 2007 for testing the changed ergonomic functionality on the water.

4.3. Guest project "Assistance Systems"

Mid 2006, the Director of the Institut für angewandte Nano- und Optische Technologien (iNano – Institute for Applied Nano and Optical Technologies) at the University of the Lower Rhine in Krefeld, Professor Dr.-Ing. Jürgen Büddefeld, offered to carry out a guest study for the "Fit & Sail" project supplementary to the work on the ComfoDrive project, to ascertain which procedures and techniques are used to simplify manoeuvring in professional shipping.

We gladly accepted this offer with many thanks.

The results of this guest study were presented in summer 2007 and published in the

> IBoaT report 3.5:
> Jürgen Büddefeld, Study: Status of developing assistance systems and their technologies for supporting navigation and manoeuvring at close-up range, among others for professional shipping, August 2007

As the major result of his study, Professor Büddefeld forecasts that as already is the case on the automotive sector, assistance systems and above all dynamic positioning systems together with new drive systems (e.g. pod drives and pump jets) will in future simplify the handling also of water sport vessels, making it easier above all to control the boat safely during manoeuvres at close-up range.

Professor Büddefield ascertains that there is currently a significant development deficit in the corresponding measuring systems, e.g. in the precision of sensors for exactly defining position, speed and bearing. The institute has meanwhile begun its research work in this field.

5. Research phase 2008

The intention is to present the current results for the "Fit & Sail" project to the general public at a special booth at the BOOT 2008 boat show in Düsseldorf in January 2008. The studies will then be continued as planned.

5.1. Sports medicine study

The sports medicine approach in the "Fit & Sail" studies considers the cruise sailing yacht as sports equipment and the older sailors as the sportsmen and -women working with this equipment.

As up to now no other national or international research results are available in this field apart from the project's own results, the basic foundations for a scientific approach to "sailing for seniors" have to be elaborated in the scope of the project, using new, creative concepts.

In 2006/2007 work began on systematic observation of older sailors on cruise sailing yachts, analysing the movements involved and measuring the exertion levels.

The first results already provide clear indications of possible problems encountered by the sports men and -women with their sports equipment, particularly with regard to the basic project questions expressed in chapter 3.

During the coming season 2008, these observations and measurements are to be continued, checked and enhanced.

The aims in particular are as follows:

- to enlarge the structure of the test person group by systematic acquisition of further test persons, supplementing the age and sex structure,
- to analyse experience up to now with the sports medicine instruments used on board, implementing this experience in the form of modified, additional and new measuring procedures for examining exertion,
- to make it possible to systemise, classify and measure the activities, movement patterns and exertion situations of older sailors on board using the observations made in the project,
- to use quantitative inclusion of external parameters (e.g. wind, weather, swell, manoeuvring space, time sequences) to find additional information about the factors influencing the "use inhibitions".

5.2. Sub-project "ComfoDrive"

Installation of a second prototype of the ComfoDrive system in the large research ship "Fit & Sail" provides the possibility of examining this manoeuvring concept in both technical and ergonomic terms with a larger number of test persons in the context of the sports medicine studies being carried out in Kiel.

Suitable measuring and interviewing techniques aim in particular to ascertain whether and to what extent this kind of concept is useful and helpful as far as the helmsman is concerned, and what additional technical or ergonomic improvements would be appropriate.

Depending on the status of the market and the willingness of manufacturers to cooperate, alternative solution from other developers could be included in our studies to improve the manoeuvring techniques for cruise sailing yachts.

It would be interesting in the medium term to cooperate with interested relevant manufacturers and suppliers of manoeuvre-assisting boat accessories, e.g. in equipping a number of charter yachts with a ComfoDrive system to test the benefits and serviceability of the concept over a longer period of time and under real cruise sailing conditions.

5.3. Sub-project "Winches"

As the previous studies show, older sailors and above all women on board have increasing problems in handling the halyards and sheets on larger cruise sailing ships as they get older.

Observations on board indicate that this problem results not only from the strength required, e.g. to operate the winches for a genua sheet under wind pressure: in addition, working the winches in the lee of a sailing yacht under mean wind speeds also brings ergonomic handling problems and stress.

Apart from attempts to solve these problems by changed, ergonomic positioning of the (mechanical) winches, here it is worth examining the effects of motor-driven winches which can both haul and slacken off the halyards and sheets by pressing a button, thus clearly relieving the physical burden on the crew.

Corresponding products were not yet on the market by mid 2007. But we know from talks with manufacturers of electric winches that some companies are working at developing corresponding solutions.

Apart from the availability of suitable equipment, there is also the important question as to how the remote control systems have to be designed in ergonomic terms so as to be simple and appropriate for the crew to operate.

During 2008, the project "Fit & Sail" will remain in contact with the relevant manufacturers, so that if at all possible we can gain experience with prototypes of suitable winches on board our research boats.

6. Summary, outlook, future projects

The water sports branch is currently facing a need to deal with the issue as to whether and how it wants to deal in the coming years with changing general conditions characterized by

- demographic developments in the next decades with decreasing numbers of young people and increasing numbers of older people,
- the current age structure among owners of larger yachts,
- the observation that older active sailors tend to stop cruise sailing from an age of about 70 years,
- gerontology forecasts of ever healthier and older "fit seniors".

The project "Fit & Sail", a cooperation between the Federal Association of the Nautical Industry in Cologne, the Institute for Sport and Sport Science at the University of Kiel and the Institute for Boat Tourism in Bonn, is breaking new scientific ground in looking at the following fundamental questions:

a) Why do older sailors give up cruise sailing from an age of around 70 years, although they enjoy sailing, are adequately healthy and physically fit and although they subsequently continue to drive cars safely without any problems?

b) What can the nautical branch do to keep potentially older "drop-outs" on their yachts for a further 5 to 10 years, i.e. until an age of 70 – 80 years, permitting them enjoyable, pleasant sailing?

As part of the project, during an initial research phase in the 2007 sailing season, the sport institute at the University of Kiel examined altogether 26 male and female test persons with regard to their basic physical capability and also (14 test persons) during typical activities and exertions on board our research yacht Hanse 341 "Fit & Sail".

The sports medicine studies produced several results:

1. The strength required to handle halyards and sheets on cruise sailing yachts is increasingly tiring for senior sailors as they get older. Some activities, such as setting the mainsail, can bring sailors to their absolute limits from an age of 60 years.

2. Manoeuvres with a conventionally motorised sailing yacht in confined harbours, locks and canals (together with complex sailing manoeuvres such as man overboard) cause considerable stress in less experienced helmsmen, which is felt to be an increasing burden as they get older.

3. The measured exertion levels, e.g. as heart rate in bpm, depend on the activity, possibly wind and weather, and on the fitness and experience of the individual sailor, but not on his age. However, these exertions are felt to be increasingly tiring as they get older.

4. In addition, the work on board once again confirmed that the physical mobility of the sailors also decreases as they get older, and that the older sailors find it increasingly difficult for example to climb on board a large yacht or bend down to one of the lockers.

Parallel to these sport medicine studies, the Institute for Boat Tourism also dealt with a technical sub-project called "ComfoDrive" which looked at concepts to provide a greater degree of safety and control when manoeuvring a yacht under motor power.

The provisional result of this work was presented in mid 2007 as the first prototype of a system consisting of main machine, two thrusters and a joystick as central control interface. The system was installed on board the project's smaller test yacht, a Neptun 22, and very successfully tested during a sailing trip in summer 2007.

Contrary to expectations, in spite of the relatively simple basic concept, this system proved to be amazingly complex and intricate when it came to the details of the algorithms for the electronic control module and the ergonomic demands made of the joystick geometry.

A second modified prototype is to be built and tested on the "Fit & Sail" in October/November 2007.

Thanks to generous support from sponsors in the water sport branch, the work carried out on the project "Fit & Sail" produced initial basic results in this new field of research by the end of 2007.

Both the sports medicine studies and the work on the new technical solutions for reducing exertion levels and increasing safety in cruise sailing above all for older sailors will therefore be continued, expanded and enhanced in the years ahead.

Parallel to the current work, since mid 2007, negotiations have been in progress with the Arbeitsgemeinschaft industrieller Forschungsvereinigungen (aif – Consortium Industrial Research Associations) in Cologne and the Center of Maritime Technologies (CMT) in Hamburg on a subsequent project to obtain "age- and sex-related reference data (standard data) of the physical capabilities of sailors on cruise sailing boats".

This project is being given an estimated 2.5 year term and aims to provide construction engineers and designers in the water sport branch with the data needed for specific design of the limit values for exertions and movement sequences so that certain target groups (e.g. 70-year old women on board) can cope with the activities involved without undue over-exertion.

Work is expected to begin on this additional project by the end of 2008.

7. List of figures and inscriptions

Inscriptions of the figures

page 4, Fig. 2

Altersgruppe ..... J	age group
Anzahl Personen (Mio.)	Number of persons (million)
Jahr	year

page 4, Fig. 3

relative Körperkraft	relative physical strength
Männer	men
Frauen	women
Alter	age

page 6/7, Fig. 4/5/6

sehr, sehr anstrengend	very, very tiring
sehr anstrengend	very tiring
anstrengend	tiring
etwas anstrengend	somewhat tiring
leicht anstrengend	slightly tiring

page 11, Fig. 7

Belastungszone	exertion zone
sehr, sehr anstrengend	very, very tiring
sehr anstrengend	very tiring
anstrengend	tiring
etwas anstrengend	somewhat tiring
leight anstrengend	slightly tiring
aerobe Schwelle	aerobic limit
anaerobe Schwelle	anaerobic limit
Herzfrequenz (S/min)	heart rate (bpm)

page 12 Fig. 8

Anzahl Probanden	number of test persons
Männer	men
Frauen	women
Altersgruppe	age group

Page 13, Fig. 9

% der Probanden	% of test persons
Belastungen (Männer)	Exertion levels (men)
sehr, sehr anstrengend	very, very tiring
sehr anstrengend	very tiring
anstrengend	tiring
etwas anstrengend	somewhat tiring
leicht anstrengend	slightly tiring
Aktivität	activity
Ablegen	casting off
Groß setzen	setting the main sail
Wende	turn
Halse	jibe
M ü. Bord	man overboard
Gross einh.	hauling the main sail
Anlegen	mooring

page 14, Fig. 10

% der Probanden	% of test persons
Belastungen (Frauen	Exertion levels (women)
sehr, sehr anstrengend	very, very tiring
sehr anstrengend	very tiring
anstrengend	tiring
etwas anstrengend	somewhat tiring
leicht anstrengend	slightly tiring
Aktivität	activity
Ablegen	casting off
Groß setzen	setting the main sail
Wende	turn
Halse	jibe
M ü. Bord	man overboard
Gross einh.	hauling the main sail
Anlegen	mooring

page 15, Fig. 11

Herzfrequenz	heart rate
Alter	age

M ü. Bord	man overboard
Anlegen	mooring

page 16, Fig. 12

Herzfrequenz	heart rate
Alter	age
Groß Setzen Männer	setting the mainsail, men
Groß Setzen Frauen	setting the mainsail, women

page 17, Fig. 13

Joystick	joystick
ComfoDrive-Elektronik	ComfoDrive electronic module
Elektronische Motorfernbedienung	Electronic motor remote control
Hauptmaschine	main machine
Bustrahlruder	bow thruster
Heckstrahlruder	stern thruster

8. List of the IBoaT reports for the Fit & Sail project

IBoaT report 3.1:
Wolf-Dieter Mell, Study: long-term measurement of the cardiovascular exertion during cruise sailing and everyday activities, September 2005

IBoaT report 3.2:
Wolf-Dieter Mell, Pilot study: comparison of the effects of vibration training and cruise sailing on jumping capability, December 2006

IBoaT report 3.3:
Burkhard Weisser, Wolf-Dieter Mell, Methodical indications for diagnosing changes in physical capabilities of older sailors following cruise sailing trips, March 2007

IBoaT report 3.4:
Wolf-Dieter Mell, Concept ComfoDrive: Dynamic, ergonomic and safety aspects of manoeuvring sailing yachts under motor power, August 2007

IBoaT report 3.5:
Jürgen Büddefeld, Study: Status of developing assistance systems and their technologies for supporting navigation and manoeuvring at close-up range, among others for professional shipping, August 2007