

Work load and Workperformance-Curves

Interdisciplinary Research Project: Principles of Work Scheduling

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Purpose

This research project was established to develop a "connection" between the daily working hours and the resulting performance of the workers. The research concentrates on the sector of carcass work, especially with the focus on bricklayer's work, formwork work, reinforcement work and concreting. The first step of the investigation, which is presented in this poster, was the monitoring of the heart rate as a personnel body parameter during the working process and the illustration of the influence caused by pre-workload and temperature on the heart rate for different working tasks.



Method

The connection between workload and fatigue will be determined for the first time by combining three interdisciplinary investigation methods, which were until now independently used. The first part is the REFA-Analysis which was tested and approved in many workflow analyses. These can also be used as reference for the examined observations in this project. The second part consists of medical test series. All the proposed tests are standardized and frequently used. The tests consist of heart-rate monitoring while performing the working tasks and additional lab research to determine the individual training level. The results of these tests could lead to other possible cross references and therefore the results could be used in other industry segments. The last part of the investigation is the observation of the performance while executing different working tasks. Additional to these three parts climatic influences were indexed, which is necessary in order to describe and compare different climatic states.¹

Findings

The main findings of the first step of the research project can be divided into three different groups:

- Allocation of the different parts of the working tasks
 The figures 1 to 4 show the allocation for the first and second category level of activity tasks for two individual working types (foreman and unskilled worker) who perform bricklayer's work. These two figures for each level of categories illustrate the immense difference in the allocation of the working task for these different groups in the sub-categories while in the level of categories the allocation is nearly the same. In addition to the overall-allocation there was a second analysis whereby the allocation of the tasks during one work day has been brought up.²
- Climatic influences
 Before investigating the connection between the heart rate and the work task, the climatic influences on the heart rate were verified. Therefore the influence of the temperature on the heart rate was examined for different cases of pre-workload, expressed as mean heart rate from the beginning of the workday until the observation of the work task. From the results of the example, illustrated in figure 7, the conclusion could be drawn that for the investigated tasks and temperatures there was no significant connection between heart rate and temperature.
- Correlation of heart rate and pre-workload
 The second step of the analysis was the search of a correlation between the heart rate level for a specific work task, expressed as percentage of the heart rate of the individual consistent performance limit (HR_{LTP1})³, and the corresponding pre-workload. For different work tasks this correlation could be determined by a simple regression. The results of the analyses for four different tasks are shown in the figures 5 and 6.

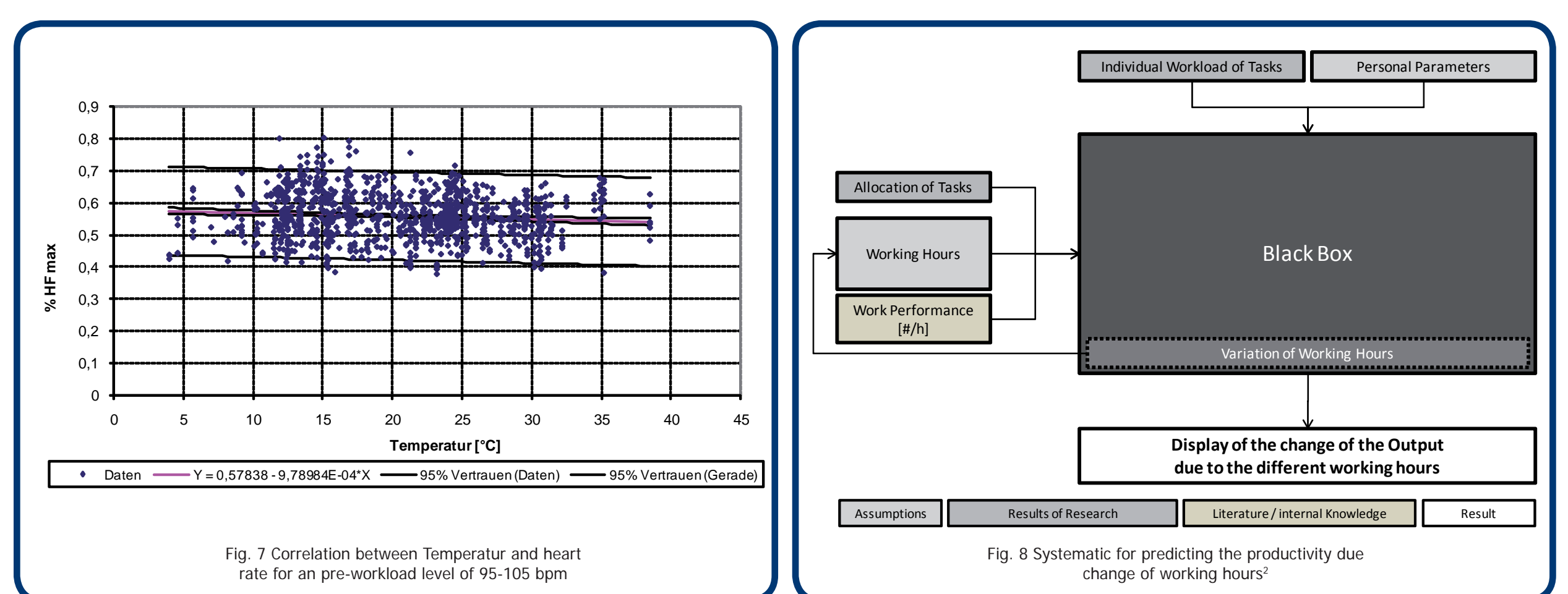
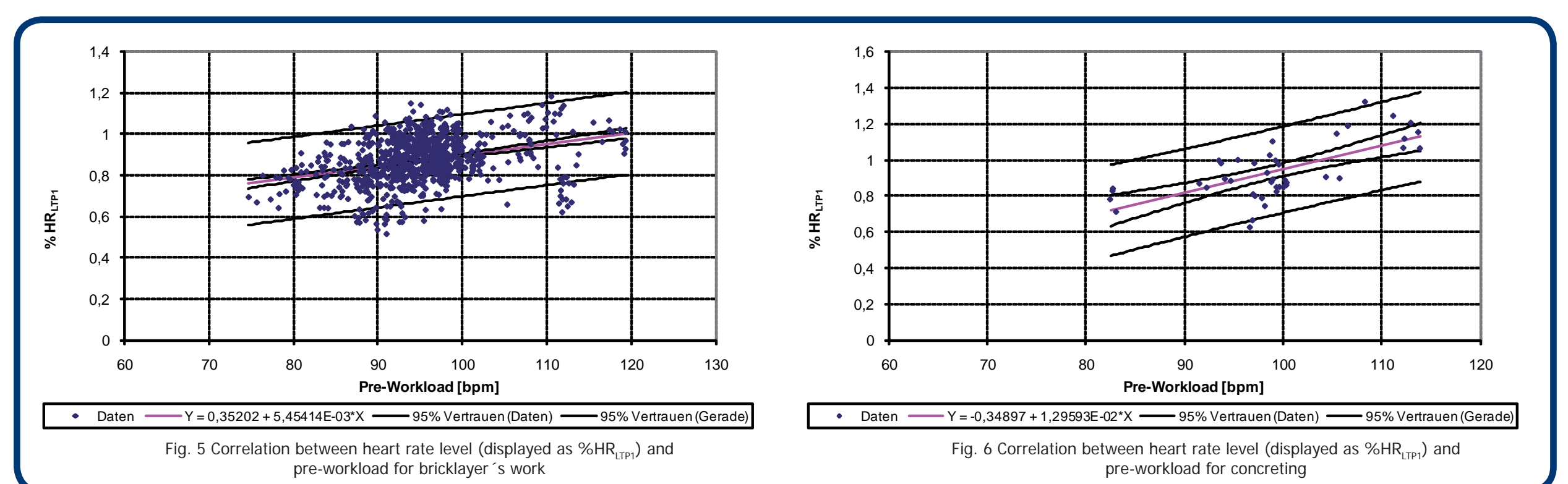
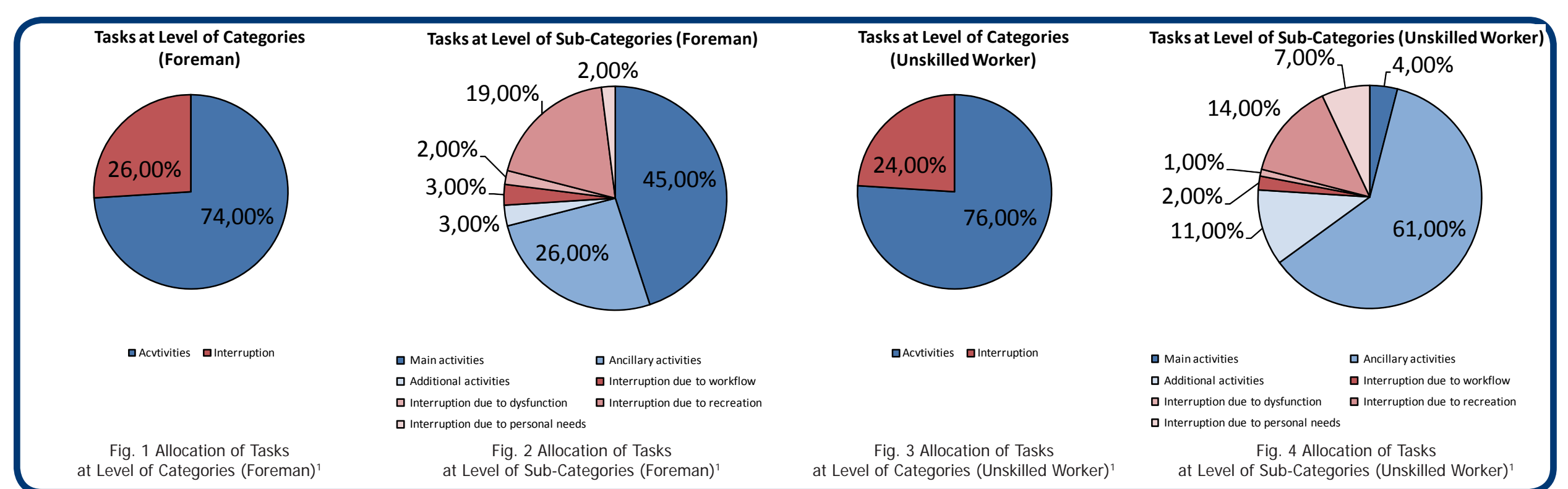
With this information and the additional knowledge about the output of the work tasks it is possible to make a prediction of the individual performance by using a calculation model as shown in figure 8.

Discussion

The allocation of the work tasks shows that there is a broad difference depending on the type of worker. With this knowledge it is important for further analysis that not only the single worker but also the working group in which he is involved has to be observed altogether. The results achieved show that there is no significant connection between the temperature and the heart rate for the investigated task but it needs to be mentioned that on the observed sites the weather condition had been stable for weeks and didn't change significantly from one day to the next. Therefore it could be suggested that the workers were accommodated to the conditions and on consequence were no major influences notable. Looking at the different working tasks and their resulting heart rate depending on the pre-workload it is recognizable that different tasks cause a higher or lower heart rate as it is shown in figures 6 and 7 for bricklayer's work and concreting. According to this knowledge it is very important to know the different tasks that have to be fulfilled by the workers for which the forecast should be done.

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Conclusion

The existing working curves by Lehmann⁴ or Burkhardt⁵ and Winter⁶ present only one working curve for all kinds of tasks. Looking closer Lehmann, who was an occupational health physician, makes a differentiation between exhausting and very exhausting work, but he never explains the difference between them and his predictions were made for performing only similar exhausting working tasks for the whole day. Burkhardt and Winter on the other hand were civil engineers and invented their curves by observing working tasks with heavy earth-moving-machinery. This for a special segment of the construction industry gained knowledge was then used for all kinds of duties.⁷ With the before shown new knowledge about the allocation of the working tasks and their different level of strain it is necessary to reconsider the nowadays often used curves without taking a closer look on the individual boundary conditions. With the new systematic illustrated in figure 8 a prediction of changes in productivity due to the change of working hours is possible as it was possible with the existing curves. At the same time different working tasks carried out on one day as well as the composition of the working group on the construction site can be taken into account.⁷

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