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SUMMARY OF DOCTORAL THESIS

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Title: An Ergonomics-based Critical Evaluation on Forest Work
(A Case Study in Pine Plantation in Java Island, Indonesia)
（　森林作業の人間工学的評価（インドネシア、ジャワ島のマツ人工林の場合）　）

Because of growing demand for timber, depletion of wood from natural forests and the importance to protect its natural forest, Indonesia has developed plantation forest. Plantation forest in Java Island with Tectona spp. (teak) and Pinus spp. (pine) as predominant species is considered as the most properly managed plantation. To cope with huge potential labors seeking for the job in this island, forestry system is based on labor-intensive system. Thus, forest operations are carried out by manual or semi-manual system means less application on the mechanization.

However, forest workers involve in this industry on a basis of self-employed worker and considered as non-professional worker. The forest workers also are living in the world of poor. Observation on social economic aspect of a forest worker community indicates that they live below the poverty line (World Bank standard). Another aspects should be taken into consideration is work productivity-based payment system. The system has triggered workers to emphasize their focus mostly on work productivity, and give less attention to the most important aspects: safety and health during work. In the other side, manual or semi manual forest work is considered as heavy work cost to heavy workload. This situation, then, in the end has triggered such a stagnant and violent working environment that limits workers to develop their living status in a long term.

In answering this situation, this study therefore, emphasizes the evaluation on both workload and work efficiency on the plantation forest work. The workload has become my main concern, as human have both certain assets and liabilities, and certain capacities and limitations (especially in physiological term). However, enhancing work efficiency that closely associated with work productivity also turn out to be one of my interest. To this, designing such a working environment that accommodates these limitations has become my study purpose.

As a basis, I developed a method on workload estimation by the use of new work

load unit so-called %VdotO2max. The measurement method can be easily applied to estimate workload in actual work (field research), without requiring such sophisticated devices, but still provides a fair assessment in estimating workload among different individuals.

Field experiments were carried out in 2003-2005 in pine plantation in Java Island, Indonesia. In my studies on thinning, resin harvesting and clear cutting operations, I classified the factors triggering high workload and low work efficiency as not-enforceable and enforceable factors. Not-enforceable factors include pine density, tree size, ground condition and season. Enforceable factors include: physical factors, technological, work organization factors and work competence of workers.

Evaluation on physical factor strongly indicated a presence of disproportion between one's physical work capacity and his task. The operations demanded 35-78% of %VdotO2max of workers, a range that its upper value is exceeding the allowable human physical workload limitation. Analysis on technological factors showed that improper and inadequate working tools greatly influenced workload and generated wasting time. Analysis on work-rest scheduling and job design showed the presence of poor work organization. Further, through skill competence analysis, it is obviously seen that poor skill of competence drove worker to work in a very low efficiency level, cost to high workload and low work productivity.

The situations indicated a need on improving the present situation. One of the attempts could be of dealing worker's physical work capacity with their task on work. In the technical point of view, the approach offered is by using the most feasible means during work. One of the examples is by using small chainsaw for small diameter tree (thinning operation). I also highlight the importance on attacking personal safety device and additional working equipments. In the case of resin harvesting, I saw a need to improve hauling and re-wounding methods. Further, I draw a need in improving the present job design by developing a work distribution between chainsaw man and helper, besides the need in applying adequate resting. I also draw attention to the importance of improving skill of competence on working technique through regular training and evaluation. Skillful workers would minimize error during actual work. Therefore they can optimize their work only on productive activity, which in the end would reduce workload and enhance the work efficiency.

However, the situation becomes immensely more complex when considering surrounding attributes, especially when it deals with the improvement and application processes as forestry is very broad industry. To this, I recommend a need of support of science-based policy, which accommodates input from the side of workers, as the workers doing the job have the best knowledge of the problem elements, which in turn would give a meaningful input of feedback. Further, as forest industry is broad industry, involving broad sides of stakeholders, a market-based policy

also should be taken into consideration. Without these two supports, irrespecti ve of skeptical thoughts, it might be difficult to create such a favorable and const ructive working environment, which benefits to all stakeholders involving in this i ndustry.