

# Increasing Task Administration Efficiency by Means of a Customizable ICT Solution

Marek Musil and František Smrčka

Department of Technical Studies, College of Polytechnics Jihlava, Czech Republic

[marek.musil@vspj.cz](mailto:marek.musil@vspj.cz)

[smrcka@vspj.cz](mailto:smrcka@vspj.cz)

**Abstract:** In production companies, managers frequently deal with inefficiencies caused by employees learning about new tasks with a considerable delay. The paper focuses on solving the lack of real-time interaction in currently used task administration systems by means of an ICT solution. The main causes of the inefficiencies consist in insufficient real-time information on the sides of both workers and managers. Employees view updates in the information system randomly, thus increasing unnecessary periods of idle time, while their superiors are not fully informed about the status of tasks in progress and about current workload of individual workers. The presented ICT solution was developed for production companies and implemented for the purpose of administering production line failure records. The solution is based on informing employees about a new maintenance task online in real time, using a combination of the designed information system with a mobile phone. The presented system utilizes advanced information technologies – cloud messaging, mobile applications, and web applications. The employee will be equipped with a smartphone with a specially designed application. By a notification sent to the mobile phone, the employee will be immediately informed about the task assigned. As regards task administering, employees enter information about the phases of task execution and managers are informed about the status of executed tasks. Another key feature of the system is providing managers with managerial overviews and compiling reports in order to monitor a number of key indicators. The Unified Process (UP) methodology was used to design the information system. The system accelerates the process of receiving tasks by individual maintenance workers after a failure has been reported, an online overview of the status of work on failures, including a managerial overview of the work of individual workers and the total time spent on solving the task (e.g. a production line defect removal). The system is designed to be universally applicable in other workplaces.

**Keywords:** Management system, ICT, Employment, Managerial reports, Information system design, Task administration

---

## 1. Introduction

Work task recording is an integral part of a production company operation. New tasks may occur randomly and can be unexpected. It is crucial to inform workers about new tasks and have effective records on task solving status. The paper addresses this task management issue on the example of recording machine failures in manufacturing companies. As for task registration, the paper treats machine failure registration as a particular real-life problem and an integral part of the manufacturing process. The shutdown of a production line due to its failure has a fundamental negative impact on the economy of the company. The lack of real-time notification is a major problem, and the main cause of lags. Existing methods of registration, i.e. using of a simple table in Excel documents, simple (and) static information system, paper form of evidence, and mainly oral communication/transmission of information, are typically ineffective and inefficient as they do not allow interactive notification about the failure, and significant time lags, resulting from passing the information among workers, occur between failure repair stages. This then has a major impact on repairing the failure and limiting production. In addition, the superior maintenance worker (manager) does not have an overview of what individual maintenance workers are currently doing and with what efficiency.

The ICT solution and its implementation as described by the paper is original and not yet presented, aimed to improve existing ICT solutions. The presented solution notifies a machine failure entered into the system in real-time to a competent worker (maintenance, repairman) who accepts the task to fix the failure. The superior maintenance worker is moreover informed about failures that are not accepted and solved within a short time period after being entered. It thus guarantees that the failure will not be ignored and the production becomes efficient. The topic of production efficiency is discussed in Soewito et al. (2019).

Mobile technologies, namely mobile applications and such features of mobile operating systems as cloud messaging and real-time notifications, are currently receiving a great response (Notifications overview, 2023). As for the trends in the area of mobile technologies, numerous papers present mobile technologies as tools for creating interesting mobile applications. A growing number of solutions use mobile applications and cloud messaging. Some practical examples of how mobile technologies has seen a significant boom and penetrated daily activities in recent years can be found in (Musil, 2021), (Musil, Smrčka, & Novotný, 2016), (Musil, & Novotný, 2015). Real-time notification, i.e. a tool informing about new events in real time, has lately become frequently used. Real-time notification has attracted significant attention from the scientific community as

seen from its abundant practical applications. Firebase Cloud Messaging is an instance of real-time notification and cloud messaging. The use of real-time notification can be found in multiple studies, e.g. (Zhao et al., 2014), (Villarreal et al., 2009); (Bussadee et al., 2016); (Gore et al., 2017); (Heryandi, 2018); (Firdaus et al., 2019); (Jiříček et al., 2022). Moroney (2017) representatively summarizes the real-time notification of Firebase Cloud Messaging (FCM). Firebase Cloud Messaging and notifications are used in Heryandi (2018); Firdaus et al. (2019), namely for the purpose of sending real-time notifications in student academic activity monitoring by means of Firebase Cloud Messaging. Over time, real-time monitoring in industrial applications has received a considerable attention (Bian et al., 2021), (Bílek, & Musil, 2022), (Cai et al., 2020), (Dong et al., 2019), (Han et al., 2021), (Chen et al., 2020), (Choueiri et al., 2020), (Jonathan et al., 2019), (Kim et al., 2021), (Yu et al., 2021), (Zhang et al., 2020). However, the mentioned studies usually use a computational machine learning method. We present a similar solution, i.e. management system for integration of the disabled on the labour market in (Smrčka, Musil, & Chalupová, 2022). For the purpose of task entering, a mobile application is used, for example, in (Smrčka et al., 2022b).

## **2. Problem Description**

There is no unified functional system of production line failure registration in manufacturing companies. To record maintenance tasks, a manager typically uses a table (created e.g. in MS Excel) or a simple information system. However, such a solution does not provide full information online. The occurrence of significant time lags is the key issue. The failure or task registration process has the following pitfalls. The production line worker notifies a failure to a manager or a maintenance worker or they enter it into an information system. The maintenance worker learns about the failure with a significant time lag. They randomly monitor the list of registered failures in the information system, which, besides, must be updated in the case of a web application. A web application solution does not make it possible to notify workers about new changes online. The manager does not have a quick overview of what each maintenance person is doing and does not know who to assign the task to. They must determine which maintenance workers are available and find a suitable worker to assign the task to. The maintenance worker is also faced with deficiencies in the process of failure solution registration. The maintenance worker performing the assigned repair cannot record individual repair steps quickly into a system. They can either enter the information about completing the task into an information system later (not quite in real time) or inform a manager personally. In cases that the production worker notifies directly the maintenance worker on a failure, the information does not reach the manager, who thus cannot record the task. The maintenance worker may fail to accept the repair task as they may be working on another task.

To sum up the limitations of the presently used methods: time lags arise in many places, thereby delaying the moment of solving the failure. This can affect the production and company economy.

## **3. Methodology**

The UP (Unified Process) methodology is used to design an information system for the task administration system. It is based on the SEP industry standard – Software Engineering Process. The UP is an abbreviated designation of the USDP (Unified Software Development Process) industry standard. It is a generic process for the UML – Unified Modeling Language. The UP is divided into individual iterations, each of which goes through five basic work processes: setting requirements, analysis, design, implementation, testing, iteration in UP (Schmuller, 2001).

A class diagram describes the system's static structure and shows data structures and operations on objects and the relationships between the objects. A use case diagram shows the behaviour of the system as seen by the user. Below, we describe the proposed solution and present several related UML-diagrams. The purpose of the diagrams is to describe the functionality of the system.

### **3.1 Research Objective**

We cooperate with a major company that deals with the issue of failure task administering in the industrial area. The company is dominant and has many years of experience. The company creates software application for automotive and made a request to implement/create an effective application using ICT. In addition to the cooperation, we address/contact an industrial factory to get detail specification of issues and lacks in production.

In cooperation with experts from the production sphere, we identified key problems and proposed solutions. This paper presents the design of a system solution based on the obtained requirements and its resulting

implementation. The system is based on ICT technologies such as Firebase Cloud Messaging (FCM), the mobile platform and its features, the mobile application, and the web application. The proposed solution removes the identified shortcomings; it is unique and not yet presented. Moreover, it enables generating management reports, planning regular maintenance (a task similar to repairing a failure), and it can also be used for attendance records.

### 3.2 Proposed Solution

The problem domain is described in Fig. 1. Notifying is implemented through a real-time notification sent to the mobile application. The production line worker enters a failure on the production line into the system via an application on a mobile phone or tablet. Maintenance workers in charge of the respective production line are informed about the failure via a mobile application (real-time notification). Maintenance personnel accept the task for resolution and enter this fact in the mobile application. If the failure is not accepted by one of the maintenance workers within a certain time limit, then the manager is informed. They then assign the task to one of the maintenance workers personally.

The process of solving the repair of the production line: When solving the task, the start time, the end time and the time of the individual phases of the repair work are recorded. Maintenance workers accept the repair, enter the progress of the repair and the completion of the repair in the mobile application. The manager assigns the task to the selected maintenance worker and has an overview of which task the workers are working on. They can see at what stage the solution of the task is. Another key feature is the provision of management reports for the purpose of monitoring key work indicators: the time during which the worker accepted the task; time spent on solving the task; time spent on solving the task by individual workers.

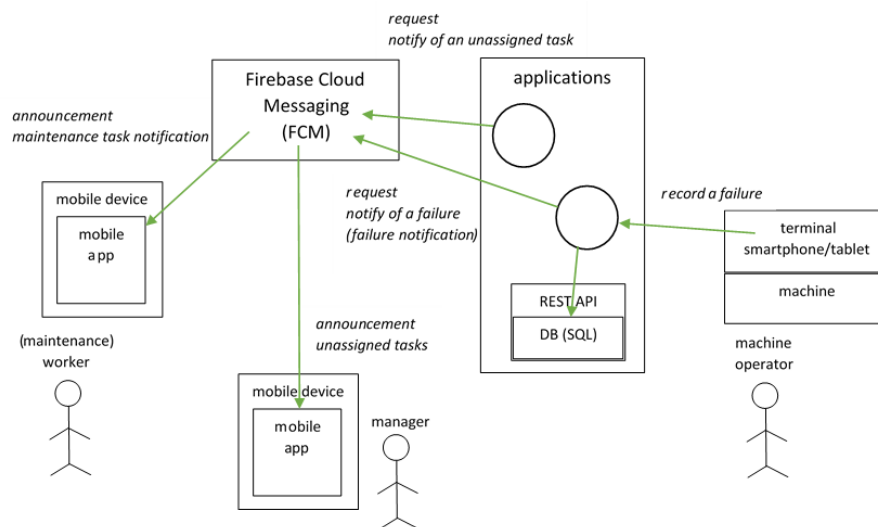


Figure 1: Problem case description: machine failure information system

By means of this solution, the time lags between the failure occurrence and the notification of the failure to the worker (maintenance technician) are minimized, and by using the application, the state of a pending task and searching for an available maintenance technician is minimized.

## 4. Design of the Task Management System

The following chapter describes a system designed for task administering. It presents UML diagrams that depict the proposed system and explains its functionalities.

As tasks are recorded and processed by the information system, competent workers can be informed of new tasks and managers of unassigned tasks (when the time limit for task assigning expires) in real time by means of a mobile application. Via the mobile application, the system enables a worker to book a task for execution and a manager to assign a task manually to a worker. Another key feature of the system is providing managers with managerial overviews and compiling reports in order to monitor a number of key indicators: the response time of booking the task, task completion time, task completion overviews for individual workers, and an overview of tasks assigned at individual workplaces, including the evaluation of task performance costs.



Figure 2: Use case diagram showing key operations

The system allows a worker to keep records of tasks and, within a task, to record the time (beginning and end) of partial steps of the task execution. The work interruption function and its recording then enable efficient determination of the net duration of the time spent on the task execution. Besides, a list of tasks under execution, a list of finished tasks, and a list of currently interrupted tasks (break) can be compiled. The system implementation provides fundamental information for managers such as time load, task lists, and statistics. Reporting provides information for setting task metrics.

To understand the logic of the solution, we now present the system functionalities. The system design makes it possible to decrease the time lag between partial task states. The time a worker spends solving the task does not affect our system. The worker is immediately informed about a task, they can start work on the task immediately and keep efficient record of the task execution. The considered system functionality and process procedures are shown in the following models. The sequence diagram (see Figure 2) shows the course of activities resulting from the described problem solution and captures the task handling procedure and the unassigned task execution procedure.

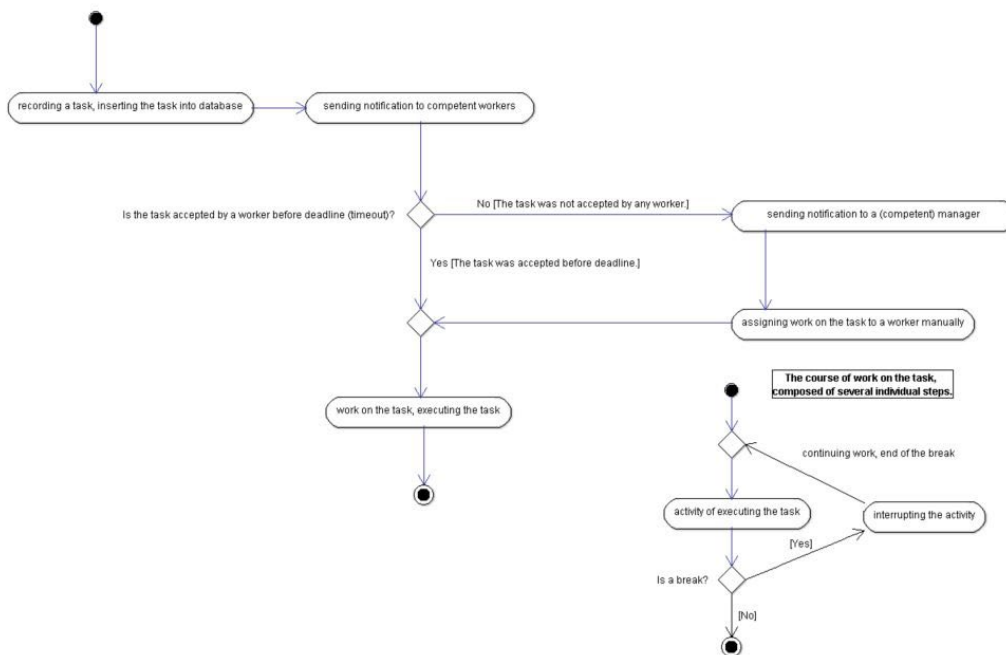
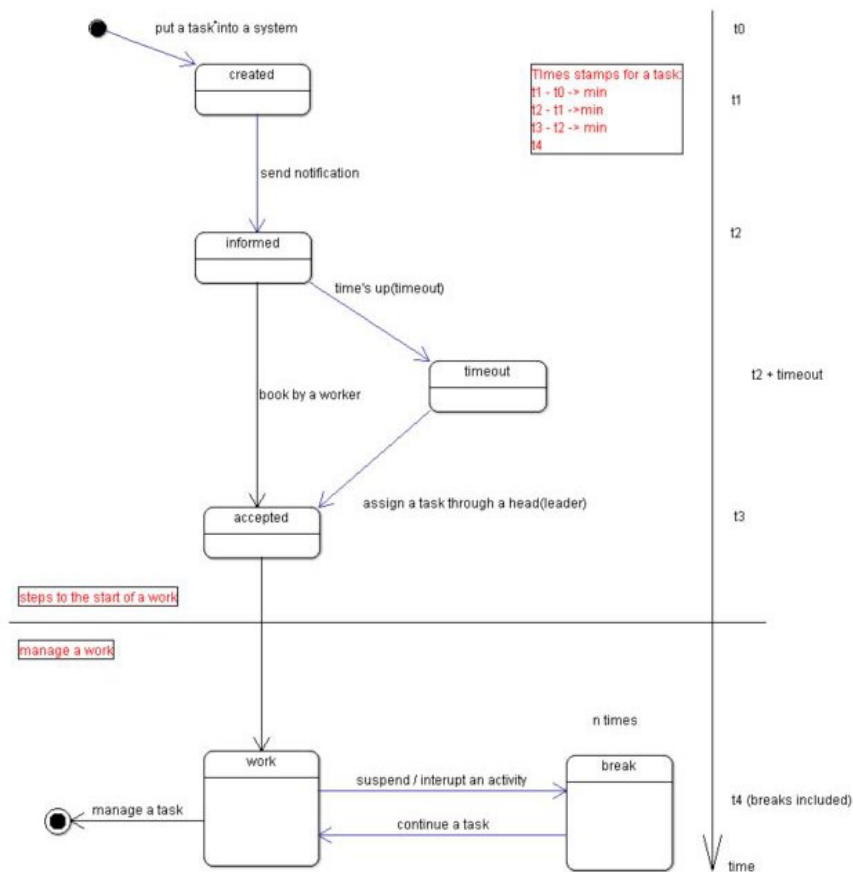


Figure 3: Process map. Diagram of activity shows the task processing procedure

## 5. Results and Discussion

The procedure of task handling consists of a sequence of partial steps (see Figure 3) and achieving time saving is shown in Figure 4, highlighted red. The work lag is minimized by quickly passing information about a new task and thanks to ongoing activity recording. The time of new task information providing (lag) is minimized by the mentioned procedure. The task is inserted to the system via a mobile device (worker's mobile application, a tablet placed at the workplace). Thanks to the immediate recording of the task in the system (through the mobile application) at the place of the requirement origin, the lag of  $t_1 - t_0$  is minimized. Obtaining the notification (about a new task) and its displaying in the mobile application minimize the  $t_2 - t_1$  time lag of informing a worker.



**Figure 4: Task state diagram and time lag minimization**

The solution includes a mobile and web application. The mobile application provides real-time notifications about the failure and allows the maintenance worker to enter the phases of the work on the task (repair initiation, repair activity interruption, repair continuation and repair completion). The manager is informed in real-time about pending repairs. The user interface of the mobile application with the possibility to enter the progress of the work on the repair of the fault is shown in Figure 5. The status of the work on the failure can be easily changed using the buttons.

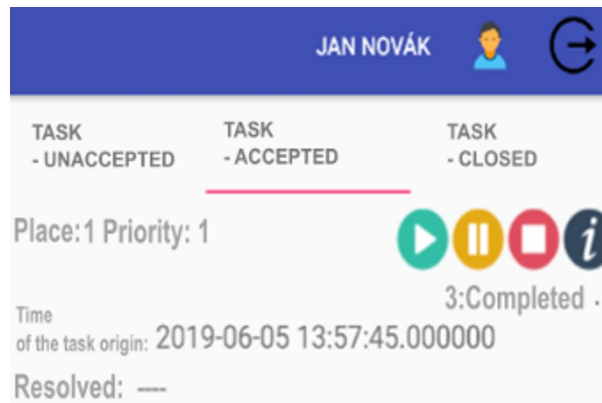


Figure 5: Mobile application – task management agenda

The web application is used by the supervisor. It enables the generation of management reports with overviews of the work performance of individual workers. The management reports can be seen in Fig. 6.

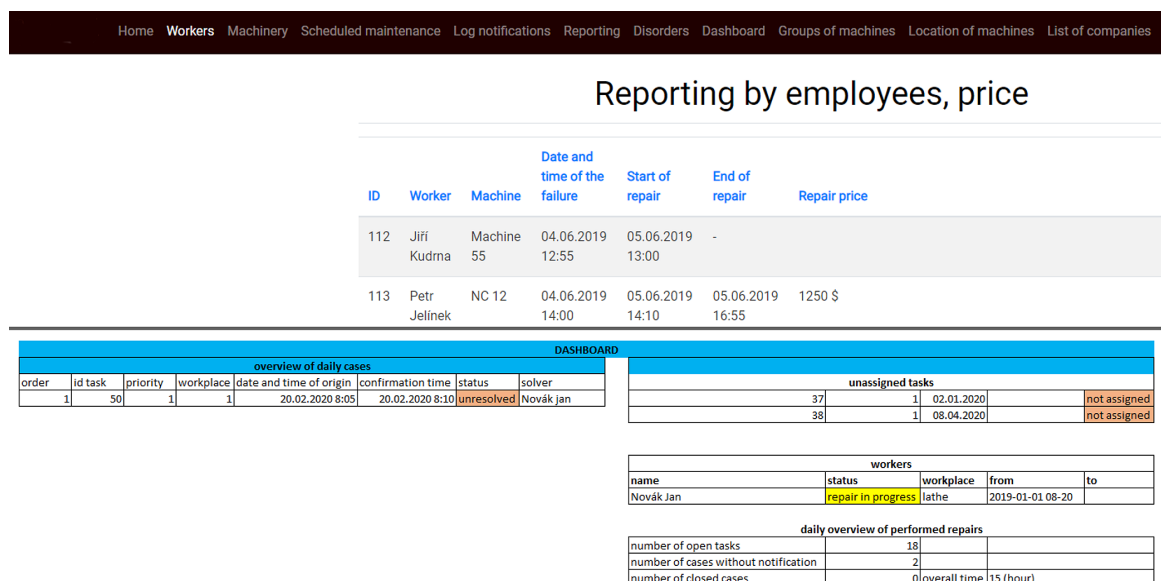


Figure 6: Web application – demonstration of management reports generation and demonstration of current failures and activities of maintenance workers

By using real-time notification, immediate informing about a new task is achieved and the time lag of notification on a failure to maintenance personnel is thereby significantly minimized. The system monitors unassigned tasks and informs the supervisor after the time interval has elapsed. This ensures that no unsolved tasks remain. The supervisor has an interactive overview of what individual workers are doing. The time delays between the individual phases of failure repair are minimized. The mentioned improvements significantly make the production process more efficient.

The presented system solves the shortcomings of the described problem and has several positives. The production line worker enters information about the failure into the system via mobile phone (instant, no time lag). Through the notification, the manager is immediately informed about the new repair task. They can find out what a worker is currently doing and what tasks they are working on. The manager can immediately assign a repair job directly to a maintenance worker.

Time saving is measured using (two) time spans recorded into database, the first time span is 'recoding the task into the system', and others are 'task booking with a worker' and 'start of work on the task'. Unfortunately, we don't have data from previous ineffective solutions and therefore, we can not compare saving times directly.

A simulation of the solved problem was created (in Simul8) and a comparison of the times of the previous solution and the new solution was made. Savings comparisons were made based on time estimates using simulation.

## 6. Conclusion

The presented ICT solution covers the issues described at the beginning of the study. The application implementation makes maintenance tasks more efficient, and, as a benefit, it enables recording of regular maintenance tasks. The maintenance worker is notified about a new failure immediately after it has been entered into the system (the time lag between entering and notification is minimized). The application identifies unassigned tasks and notifies the manager about them, so that no unexecuted task remains. The manager accesses records of the workload of individual workers. The worker records partial steps of the maintenance tasks. The time saving is the key factor of the solution, which improves production efficiency and company economy. Based on the simulation results, the improvement is in the order of tens of minutes. The presented solution can be implemented in other application areas, such as restaurant personnel service or creating disability-inclusive workplace, where handicapped workers use the mobile application to receive instructions.

## References

- Bian, S., Li, Ch., Fu, Y., Ren, Y., Wu, T., Li, G., & Li, B. (2021). Machine learning-based real-time monitoring system for smart connected worker to improve energy efficiency. *Journal of Manufacturing Systems*, Volume 61, Pages 66-76, ISSN 0278-6125. <https://doi.org/10.1016/j.jmsy.2021.08.009>
- Bílek, M., & Musil, M. (2022). Přínosy IoT systému pro diagnostiku provozu zařízení. In *Mezinárodní vědecká konference KONKURENCE* (81-89). Jihlava: College of Polytechnics Jihlava / Vysoká škola polytechnická Jihlava.
- Bussadadee, S., Suwannatria, S., Chonrawut, A., Thamwivatthana, E., Pasupa, K. (2016) Inside Me: A proposal for healthcare mobile application. 2016 Fifth ICT International Student Project Conference (ICT-ISPC), Nakhon Pathom, 85-88, doi:10.1109/ICT-ISPC.2016.7519242.
- Cai, W., Wang, J., Jiang, P., Cao, L., Mi, G., & Zhou, Q. (2020). Application of sensing techniques and artificial intelligence-based methods to laser welding realtime monitoring: A critical review of recent literature. *Journal of Manufacturing Systems*, Volume 57, Pages 1-18, ISSN 0278-6125. <https://doi.org/10.1016/j.jmsy.2020.07.021>
- Dong, Q., Kontar, R., Li, M., Xu, G., & Xu, J. (2019). A simple approach to multivariate monitoring of production processes with non-Gaussian data. *Journal of Manufacturing Systems*, Volume 53, 2019, Pages 291-304, 17 ISSN 0278-6125. <https://doi.org/10.1016/j.jmsy.2019.07.005>
- Firdaus, D., Priambodo, B., & Jumaryadi, Y. (2019). Implementation of Push Notification for Business Incubator. *International Journal of Online and Biomedical Engineering (iJOE)*, 15. 42. 10.3991/ijoe.v15i14.11357.
- Gore, S., Sonawane, N., Pawar, S., & Nerkar, M. (2017). Survey Paper on An Android Based Mobile Framework for Student Alert Notification. *IJARCCCE* [online]. 6(3), 676-678 [cit. 2020-10-16]. ISSN 22781021. Available at: doi:10.17148/IJARCCCE.2017.63158
- Han, S., Mannan, N., Stein, D. C., Pattipati, K. R., & Bollas, G. M. (2021). Classification and regression models of audio and vibration signals for machine state monitoring in precision machining systems. *Journal of Manufacturing Systems*, Volume 61, 2021, Pages 45-53, ISSN 0278-6125. <https://doi.org/10.1016/j.jmsy.2021.08.004>
- Heryandi, A. (2018). Developing Application Programming Interface (API) for Student Academic Activity Monitoring using Firebase Cloud Messaging (FCM). *IOP Conference Series: Materials Science and Engineering*, 407.012149, 10.1088/1757-899X/407/1/012149.
- Chen, W., Liu, H., Qi, E. (2020). Discrete eventdriven model predictive control for real-time work-in-process optimization in serial production systems. *Journal of Manufacturing Systems*, Volume 55, Pages 132-142, 16 ISSN 0278-6125. <https://doi.org/10.1016/j.jmsy.2020.03.002>
- Choueiri, A. CH., Sato, D. M. V, Scalabrin, E. E., & Santos, E. A. P. (2020). An extended model for remaining time prediction in manufacturing systems using process mining. *Journal of Manufacturing Systems*, Volume 56, Pages 188-201, ISSN 0278-6125. <https://doi.org/10.1016/j.jmsy.2020.06.003>
- Jiříček, P., Musil, M., Smrčka, F., & Dvořáková, S. (2022). The it solution and economy of a social enterprise project. In *Proceedings of the 14th International Scientific Conference COMPETITION* (88-97). Jihlava: VŠPJ.
- Jonathan, O., Misra, S., Ibanga, E., Maskeliunas, R., Damasevicius, R. & R. Ahuja. (2019). "Design and implementation of a mobile webcast application with google analytics and cloud messaging functionality". *Journal of Physics: Conference Series*. doi: 10.1088/1742-6596/1235/1/012023.
- Kim, J., Lee, H., Jeong, S., & Ahn, S. (2021). Soundbased remote real-time multi-device operational monitoring system using a Convolutional Neural Network (CNN). *Journal of Manufacturing Systems*, Volume 58, Part A, Pages 431-441, ISSN 0278-6125. <https://doi.org/10.1016/j.jmsy.2020.12.020>
- Moroney, L. (2017). *Firestore Cloud Messaging*. in *The Definitive Guide to Firebase*. Apress, Berkeley, CA. [https://doi.org/10.1007/978-1-4842-2943-9\\_9](https://doi.org/10.1007/978-1-4842-2943-9_9)
- Musil, M. (2021). Indoor navigation mobile application in the college building. *Logos Polytechnicos*, 12(3), 116-125.
- Musil, M., Smrčka, F., & Novotný, J. (2016). Development of apps for sports wearables devices – SUUNTO, GARMIN, RECON. *Logos Polytechnicos*, 7(4), 57-70.
- Musil, M., & Novotný, J. (2015). Application development for Recon Jet. *LOGOS POLYTECHNIKOS*, 6(4), 109-116.
- Notifications overview : android developers. Android Developers. (2023, April 19). Retrieved April 20, 2023, from <https://developer.android.com/guide/topics/ui/notifiers/notifications>

- Schmuller, J. 2001. We think in UML. Prague: Grada, 2001. ISBN 80-247-0029-8.
- Smrčka, F., Musil, M., & Chalupová, M. (2022). Management System for Integration of the Disabled on the Labour Market. In *Proceeding of the 18-th Conference on Management Leadership and Governance* (382-988). Lisbon: ACPIL, 2022.
- Smrčka, F., Musil, M., Dostál, J., & Černá, M. (2022b). Aplikace Dobrometr jako nástroj konkurenční výhody organizace. In *Mezinárodní vědecká konference KONKURENCE - Sborník příspěvků z 13. ročníku Mezinárodní vědecké konference KONKURENCE* (290-300). Jihlava: College of Polytechnics Jihlava / Vysoká škola polytechnická Jihlava.
- Soewito, B., Gunawan, F., E., & Rusli, I., P. (2019). The use of android smart phones as a tool for absences. *Procedia Computer Science*. Volume 157, Pages 238-246, ISSN 1877-0509. <https://doi.org/10.1016/j.procs.2019.08.163>. Available at: <https://www.sciencedirect.com/science/article/pii/S1877050919310816>
- Villarreal, V., Laguna, J., L'opez, S., Fontecha, J., Fuentes, C., Herv'as, R., L'opez, D., & Bravo, J. (2009). A Proposal for Mobile Diabetes Self-control:Towards a Patient Monitoring Framework.
- Yu, J., Song, Y., Tang, D., & Dai, J. (2021). A Digital Twin approach based on nonparametric Bayesian network for complex system health monitoring, *Journal of Manufacturing Systems*, Volume 58, Part B, Pages 293-304, ISSN 0278-6125, <https://doi.org/10.1016/j.jmsy.2020.07.005>
- Zhang, Z., Li, B., Zhang, W., Lu, R., Wada, S., & Zhang, Y. (2020). Real-time penetration state monitoring using convolutional neural network for laser welding of tailor rolled blanks, *Journal of Manufacturing Systems*, Volume 54, Pages 348-360, ISSN 0278-6125, <https://doi.org/10.1016/j.jmsy.2020.01.006>
- Zhao, Y., Bond, I. A., & Sweatman, W. L. (2014). An Android application for receiving notifications of astrophysical transient events [online]. Volume 6, October 2014, Elsevier, 19-27, [cit. 2020-06-10]. Available at: <https://www.sciencedirect.com/science/article/pii/S221313371400016X>