Applications and Benefits of Ethnographic Research

—Case Study of Management System Upgrade for Power Plant Construction Site—

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OVERVIEW: Hitachi has adopted RFID systems for improving reliability and work efficiency at power plant construction sites, and these have demonstrated various administrative advantages over paper-based work flows. On the other hand, sites that have adopted IT systems have also experienced problems, such as use of unexpected work practices and excessive workloads being placed on certain workers. This case study describes the application of ethnographic research to the development of next-generation construction management systems to identify the underlying problems and actual work practices.

INTRODUCTION

ENSURING that work is performed to an extremely high standard has top priority in power plant construction in order to guarantee work accuracy. Achieving this requires close management of whether worker competency and equipment satisfy the requirements specified in the work instructions. This in turn requires rigorous recording of data that includes the names of workers and the equipment they used. The construction of a power plant is a huge project that may last for five years or so and involve several thousand people. Projects of this scale face considerably greater project management challenges than those of normal construction projects.

With the aims of improving the reliability of production and quality of workmanship at power plant construction sites, and to enhance traceability and the efficiency of production and construction management, Hitachi-GE Nuclear Energy, Ltd. has been independently developing and implementing systems that use radio-frequency identification (RFID) tag technology since the 1990s. As a result, projects are now able to access and interpret information such as the latest design details or realtime updates on work progress at the construction site, facilitating fast and accurate decision-making.

When the RFID systems were introduced at actual sites, however, new problems arose. These included the systems being used in ways that differed from what was assumed in the design, and excessive workloads being placed on certain personnel, for example. In response, Hitachi adopted user experience design techniques in the development of its next generation of construction management systems in order to ensure that the systems took adequate account of the viewpoints of site users. Specifically, the development included the following four processes: (1) use of ethnographic research and interviews based on on-site observations to determine how to take account of the actual work practices of site users and the underlying problems faced by the site, (2) identification of both explicit and latent user needs, (3) establishment of development policies and the development of ideas for next-generation systems, and (4) use of prototypes to undertake repeated cycles of user evaluation and feedback of results.

This article describes the methodologies and effectiveness of ethnographic research used to identify the underlying problems and latent needs at construction sites, and its role in enhancing the capabilities of power plant construction management systems.

ETHNOGRAPHIC RESEARCH

Ethnographic research is a social science methodology for explaining the culture and lifestyle of specific groups (such as a nation or society) in terms of anthropology and sociology. It involves observing and conducting interviews with people in the target group while living among them for an extended period of time.

In recent years, the introduction of various products and services (such as information systems) has changed the way people work and go about their lives. This has led to new problems associated with the relationships between information services and people or with the relationships between people that are mediated by these systems. When used in the development of products and services, ethnographic

research can create a picture of the structure and processes of various phenomena through detailed observation of people's real actions, and through analysis of the acquired data. Moreover, by identifying patterns that relate to frequently occurring problems and understanding these at a conceptual level, it is possible to shed light on the underlying issues involved in enhancing the user experience provided by products and services that are under development.

The problem with attempting to ascertain the content of work solely through interviews is that the results tend to be biased toward those aspects of the work of which the worker being interviewed is consciously aware (the explicit aspects, in other words). Ethnographic research, in contrast, uses researchers unfamiliar with the culture and rules of the work being studied to observe what the relevant people actually do. This means that the researchers can acquire information about implicitly presupposed sets of values and about behaviors that are performed unconsciously, and in doing so they can acquire a complete picture of the work being done by the organization, including its latent needs.

ETHNOGRAPHIC RESEARCH AT POWER PLANT CONSTRUCTION SITE

The following sections describe the ethnographic research procedures conducted at a power plant construction site.

Understanding the Outline of Work at Power Plant Construction Site

Before starting the research, the ethnographers attended four days of lectures where they learned the basic knowledge of work procedures and processes needed to observe the power plant construction work, details of administrative arrangements and other work practices, and details of the construction management systems at the site, including how they were intended to be used. As part of formulating their research plan, they also visited a power plant construction site to gain a first-hand appreciation of the project scale and on-site conditions.

Research Target

The construction of a power plant is a huge project, incorporating as much as 150 km of pipes, for example, and one that involves a wide variety of people. In the case of piping, for example, these include the groups responsible for pipe manufacturing, for the storage of pipes dispatched from the manufacturer, for pipe assembly, and for piping quality control. As the plant designer, Hitachi-GE Nuclear Energy sits at the top of this hierarchy and is responsible for coordinating a large number of Hitachi and subcontracting companies whose roles are first-, second-, or third-tier. As attempting to conduct research throughout such a huge project would be impractical, the study is instead done in stages. Accordingly, the first work area selected for research was the groove fit-up* of assembled pipes, a process that is subject to the most stringent of quality control.

Field Observation Methods

Each round of research was conducted over two to three days and involved three sets of interviews and observations at different times of the day. As research progresses, if it is necessary, the scope of research should be expanded to other relevant work in order to obtain an overall picture of work practices. The research described in this case study ended up requiring three rounds.

During field observations, the ethnographers wore the same work clothes and used the same equipment as the on-site workers. This clearly differentiated them from visiting customers or administrators, and helped establish friendly relations with the workers (see Fig. 1).

Analysis Procedure

In addition to the problems and concerns expressed by the workers, the observations and interviews also collected information about informal practice being used to improve the efficiency and quality of work at the site. Rather than dealing with problems and concerns individually, the data analysis was able to uncover the underlying problems within the organization by taking a broad perspective that considered how these issues were interrelated.

RESULTS

The research identified various informal practices that contributed to quality increase. The research also discovered numerous opportunities for further improvements in quality and efficiency. The following sections describe two further improvement areas.

Site Worker Resistance to Use of IT Systems

The on-site workers understood the reasons for adopting IT systems, and used the systems provided.

* Specified methods to align the joints between pipes, valves, pumps, and other components.

Fig. 1—Observation at Power Plant Manufacturing and Construction Sites.
Ethnographers conducting on-site observations wear the same work clothes and use the same equipment as workers, being distinguished only by different colored helmets.

However, the research also found that workers were not proactive in their approach to the system, and that, for example, they would use paper to record information in the field and then enter this data into the system after returning to the office. The major reason was that the systems were designed primarily to aid management, and provided less value to on-site workers. A second reason was that the working environment did not facilitate use of the systems. In the case of groove fit-up work, the available workspace is cramped and offers insufficient space for placing a notebook personal computer (PC).

The site workers see their mission as being to complete the groove fit-up work correctly and on time, and they dedicate all of their efforts to achieving these goals. However, for the reasons described above, they have a negative attitude to the use of IT systems.

Inconsistency between Actual and Intended Work Flow

This section describes a problem that arose between the groove fit-up department responsible for assembling the pipes and the stores department responsible for their storage and delivery.

The first step in groove fit-up is pipe preparation, and before this can start a request must be sent to the store to deliver the required pipes. However, because the store covers an area equal to two or three 400-m athletic tracks, responding to such an unexpected request takes several hours (see Fig. 2). To avoid

Fig. 2—Construction Site Store.
This store is used for storage of items sent to the construction site for use in plant construction, including materials like pipes, valves, nuts, and bolts.

this problem, a rule at the site being studied was that delivery requests must be sent to the store three days in advance. In other words, the store expects to be able to get requests three days in advance in order to carry out delivery work on schedule.

Unfortunately, work does not always go according to plan for reasons such as weather-related delays or other unexpected circumstances, such as scaffolding shared with another section being suddenly removed for some unknown reason. At such times, the department responsible for the groove fit-up instructs its staff to do some other work that is ready to proceed. This helps avoid work delays in the overall project. In other words, the change to the groove fit-up work is the way to respond flexibly to such a contingency.

A sudden change of plan noted above causes the person in charge of the groove fit-up work to send a request for pipes that are needed to start work later that same day. The store staff need to put in a lot of effort to respond. This kind of urgent request will absorb the store staff's time. They are not able to meet the three days notice for regular delivery. A further result of this would cause a negative spiral in which the delay in delivery triggers another change of plan in the groove fit-up work. This conflict between, on one hand, the store working practices that assume a particular schedule and, on the other, the operational need to avoid delays to the overall project by keeping work moving forward, regardless of whether it is performed in the planned sequence or not, creates confusion and triggers a negative spiral at the work site (see Fig. 3).

The ethnographic research also identified many other problems in addition to those described above. Rather than dealing with these individually,

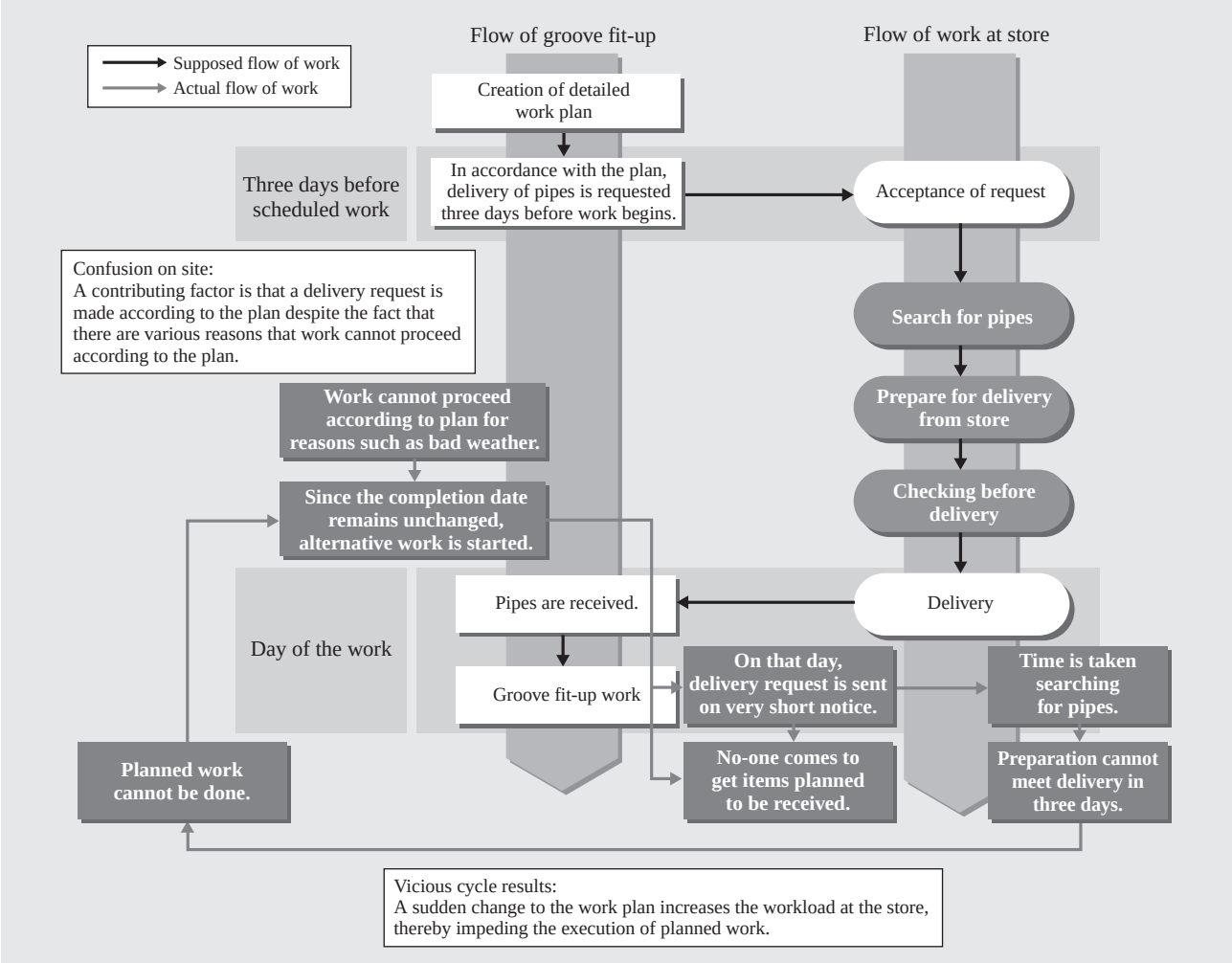


Fig. 3—Problems at Store and Groove Fit-up Workplace.
Confusion at the work site and vicious circles result when the store assumes that work will proceed in accordance with a particular schedule, whereas working practices are based on the operational need to avoid delays to the overall project, which means keeping work moving forward regardless of whether it is performed in the planned sequence.

if improvements are to be made, it is essential that a broad-based analysis be undertaken of how these various issues interrelate, and that changes be made that get to the core of the problems. In this case, an overall picture linking together problems from across the entire plant was illustrated based on Fig. 3. In this way, the interrelation of issues was clearly represented in a way it is easier to share with stakeholders.

IMPROVEMENTS TO POWER PLANT CONSTRUCTION MANAGEMENT SYSTEM

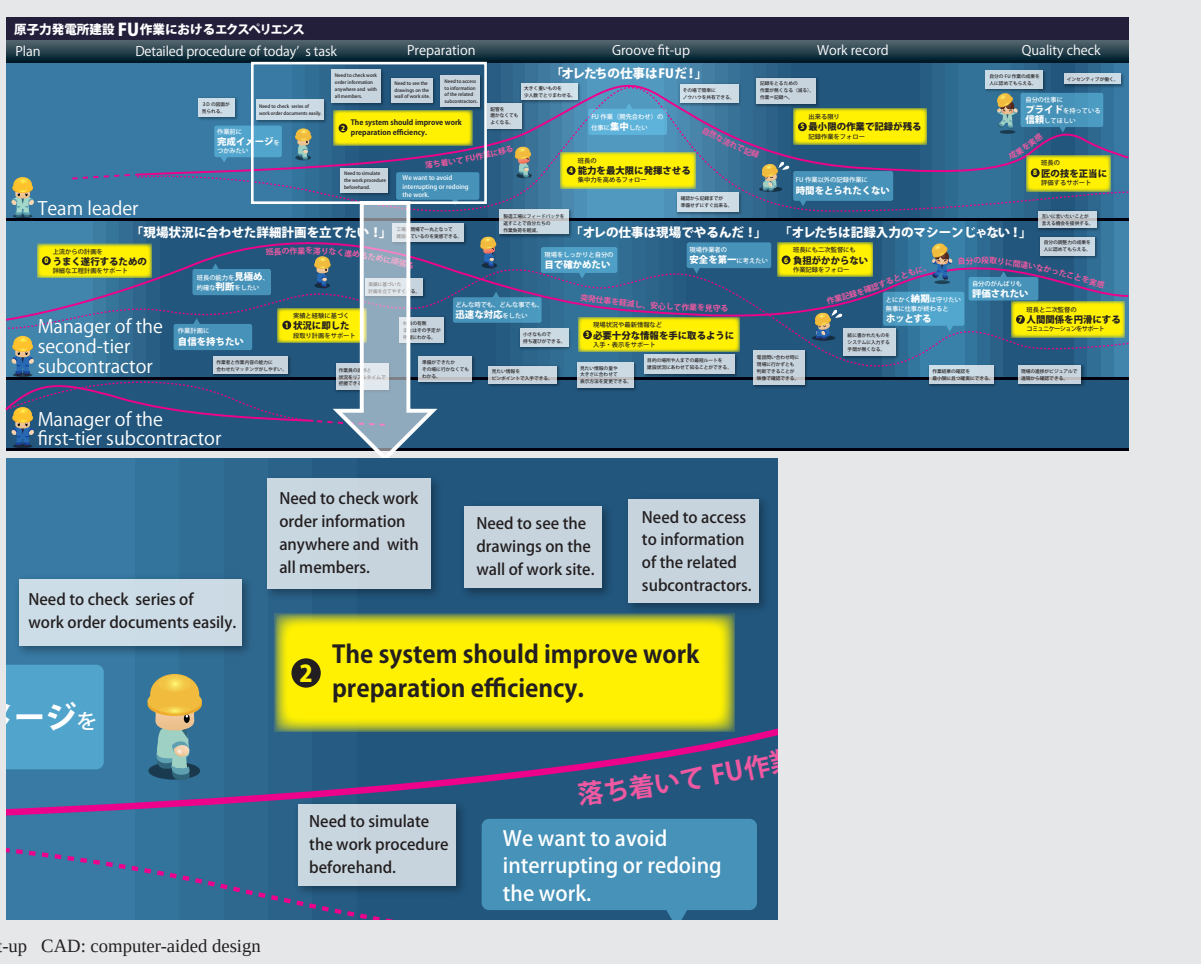
Drawing on the results of the ethnographic research, the scope of the improvement is now being broadened to include the operation of the power plant construction management system rather than just the user interface of the system.

For the groove fit-up work, an idealized operation such as how the site workers would like to undertake the tasks was drawn as Fig. 4, considering the issues described in the previous section. This chart expresses, what are the site workers' primary concerns and how those concerns would change through the different phases of their work. This includes, for example, that workers want to put maximum resources into performing their work precisely without delay, and to get work preparation done efficiently because these tasks are important but simple.

This chart allowed us to share the demands of the groove fit-up workers with stakeholders, and to extract valuable solutions for improvement from the perspective of the on-site workers.

FEATURES AND BENEFITS OF ETHNOGRAPHIC RESEARCH

As this power plant case study demonstrated, ethnographic research provides a means to identify



FU: fit-up CAD: computer-aided design

Fig. 4—Work Practices as Seen from Viewpoint of Site Workers ("Experience Table").
The horizontal axis shows work processes involved in groove fit-up, and the vertical axis shows the workers involved in those processes. The figure indicates the importance workers place on each process. The groove fit-up workers see their mission as being to perform the fit-up work accurately, in accordance with the instructions, and on time. They want to complete preliminary preparations as quickly as possible, and without complications, so that they can focus their time on the actual fit-up work.

the underlying problems at a work site. The following sections describe the features and benefits of ethnographic research.

Fact-based Analysis

Ethnographic research gathers information mainly by on-site observations.

On-site observations involve going to a site and observing what is really going on. In contrast, the interview-based investigations often used in business are typically conducted in a meeting room and have the interviewee answer questions from memory. Comparing these two approaches reveals that the information acquired in each case is very different. Interview research is effective in extracting explicit needs that subjects are not aware of. However, it is difficult to uncover the latent issues that they have taken for granted. In the case of on-site observation, in contrast, observing the subject performing particular actions, even actions of which they themselves are not consciously aware, can provide opportunities to ask them about background details. On-site observation can obtain reliable facts about what takes place in the workplace, regardless of whether or not the subject is aware of the matter.

Interview is useful in acquiring detailed background information regarding the findings from on-site observation. That is to obtain an in-depth understanding of the reasons for the action.

Ethnographic research allows us to understand "what they are doing" and "why they are doing in this way."

The following sections describe three different examples that demonstrate the features and effectiveness of analysis results obtained by ethnographic research (see Fig. 5).

Feature 1 of Analysis Results: Overall Understanding of What People are Doing

An overview of a particular work process can be obtained by identifying the tasks associated with the products or services being studied, and then also determining how that work is done, including, for example, the relationships with other departments that come about through the work and

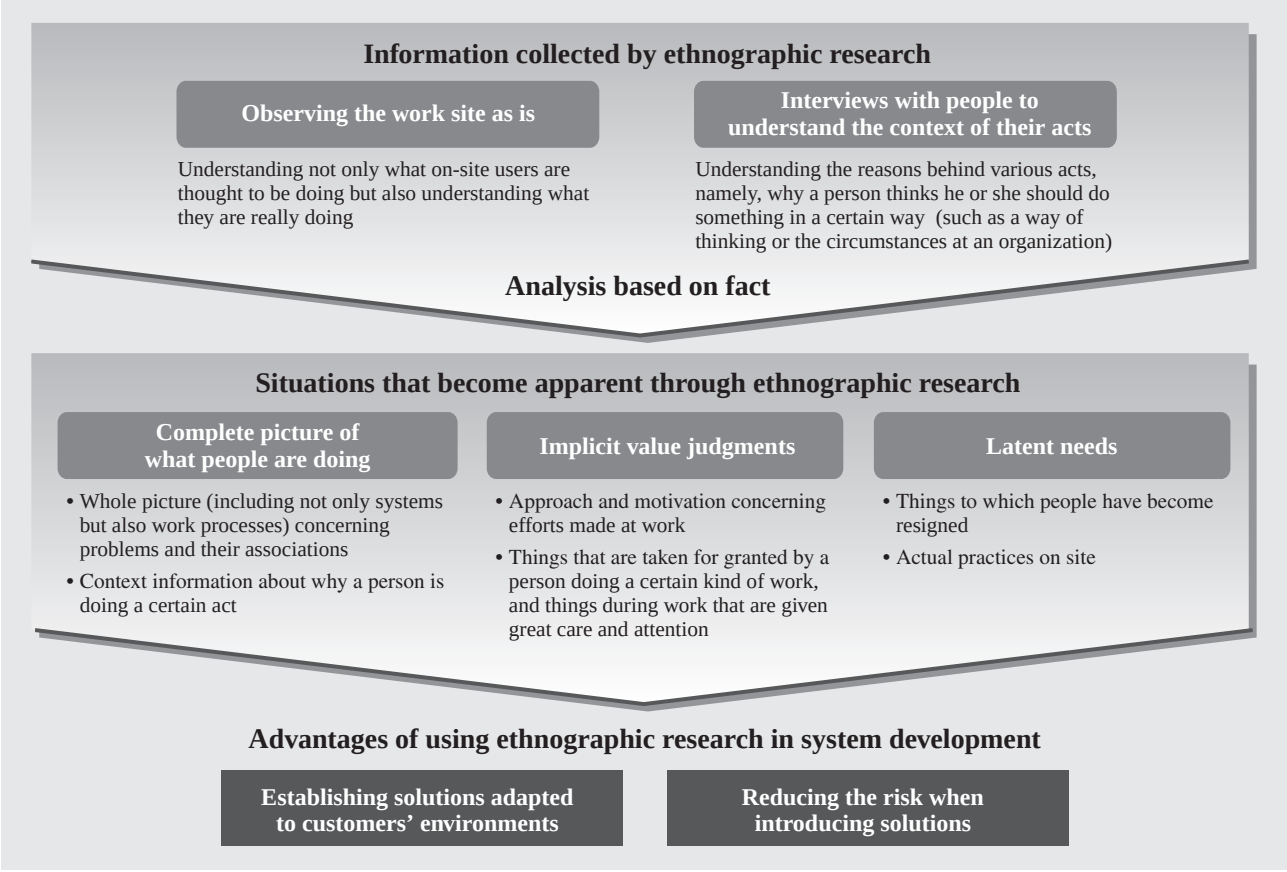


Fig. 5—Features of Ethnographic Research.
Ethnographic research can identify a kind of information, such as worker's implicit needs and values, that cannot easily be extracted by other research methods.

the conversations between people brought together by these relationships. This approach can identify not only simple system improvements but also the need for improvements to the entire work process.

Feature 2 of Analysis Results: Understanding of Implicit Values

On-site observations can collect information on numerous practices being undertaken by individuals in areas they consider important, including the use of workarounds that they have adopted at their own initiative. Delving into the details behind these practices can then uncover the values held by the workers with regard to their work, including what approach they take to the job and what matters most to them in going about their work.

Feature 3 of Analysis Results: Understanding of Latent Needs

Numerous actions at a workplace can appear unnecessary at first glance, such as sticking notes on displays and materials, or printing out and checking data before sending it electronically. Nevertheless, site workers have their reasons for these practices, such as avoiding problems or ensuring that downstream processes proceed efficiently. By identifying these problems, ethnographic research can clarify the latent needs of workers.

Effectiveness of Ethnographic Research

As described above, ethnographic research is an effective way to acquire information that is difficult to acquire by other research methods. It is a suitable method for uncovering latent needs and underlying problems in situations where the exact source of the problem is unknown but something still needs to be done about it, or when a new system has been installed but is not being used effectively.

Furthermore, a key feature of ethnographic research is that it not only helps to improve systems but also identifies potential improvements across the overall work process.

CONCLUSIONS

This article has described the methodologies and effectiveness of ethnographic research used to identify the underlying problems and latent needs at construction sites, and its role in enhancing the capabilities of power plant construction management systems.

Ethnographic research provides a means of identifying underlying problems at a site that are difficult to uncover using conventional interview-based research and questionnaires. Although ethnographic research has often been used for consumer products or enterprise systems, its use has also expanded in recent years to cover the development of systems used by specialists, such as medical information systems and semiconductor inspection equipment.

Hitachi is planning to expand its utilization of ethnographic research in its Social Innovation Business, and to use it as a means of identifying the underlying problems at a workplace.

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