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Functional identification of an internal intervention plan using the FAST approach

MESLOUB Khouloud[1], INNAL Fares [2], DUCQ Yves [3]

1 LRPCSI Laboratory of Skikda, University 20 August 1955 Skikda, Skikda 21000, Algeria

2 Automatic Laboratory of Skikda, University 20 Augest 1955 Skikda, Skikda 21000, Algeria

3 IMS Laboratory, University of Bordeaux, Bordeaux 33405, France

Corresponding Author Email: mk.technique12@gmail.com, fares.innal@univ-skikda.dz

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ABSTRACT

The objective of this work is to propose an approach to the functional identification of an internal intervention plan which constitutes an important safety barrier in process industries. This identification makes it possible to explain the different components of this emergency plan, and especially their interactions with respect to its purpose. In order to analyze and quantitatively evaluate the performance of the emergency response system relating to an accident scenario, we focus on the intervention time and the human or material resources used.

To achieve these objectives we identified the internal intervention plan via two functional FAST methods. It allows precise functional identification of the different stages of the intervention plan, it allows it to be simulated and to quantify certain performance indicators.

The proposed methodology was applied to a furnace, located at the RNK1\ skikda sonatrach complex.

1. INTRODUCTION

The FAST approach, as described in the research papers, refers to various innovative methods and technologies used in safety applications. For instance, a Fast-Data architecture was implemented to generate early response alerts for unforeseen events, utilizing a machine learning model for real-time processing **[1].** Additionally, a fast prototyping approach was presented for constructing a Doppler radar system to detect cardiac activities, ensuring compliance with health safety regulations **[1].** Moreover, the development of an intelligent detection model was discussed to check the appropriate use of personal protective equipment (PPE) for electrical hazards, aiming to enhance safety in work environments **[2] [3].** These diverse applications of the FAST approach showcase its versatility in improving safety measures across different domains, from emergency response systems to health monitoring technologies.

The FAST approach encompasses various key principles across different fields. In the context of oil and gas exploration, the Fast-Drill method involves drilling riserless with seawater at high penetration rates to reduce costs and improve efficiency **[4].** In surgical settings, Fast track surgery focuses on reducing the body's stress response to surgery through multimodal analgesia and early nutritional support, leading to decreased pain levels, shorter hospital stays, and improved patient outcomes **[5].** Additionally, in the context of tuberculosis management, the FAST strategy (find cases actively, separate safely, and treat effectively) has been associated with a significant reduction in hospital-based acquisition of multidrug-resistant tuberculosis, showcasing its effectiveness in preventing the spread of resistant strains **[6].** These principles collectively emphasize the importance of efficiency, cost-effectiveness, patient well-being, and disease control in their respective domains.

2. FUNCTIONAL ANALYSIS SYSTEM TECHNIQUE APPROACH:

The FAST approach uses a 16-item questionnaire to get information about an individual's challenging behavior.

The questionnaire is given to people who know the person, like parents, teachers, or caregivers, to find out what they think about the behavior.

Based on the circumstances that might be sustaining the problematic behavior, the FAST questionnaire is divided into four functional categories: automatic reinforcement, escape, attention, and access to tangibles. Through the analysis of the responses, experts can gather preliminary data regarding plausible causes for the problematic behavior.

It is crucial to remember that the FAST alone is insufficient to ascertain the purpose of behavior.

The data acquired by the FAST should be taken into account in conjunction with other evaluation techniques, such as experimental functional analysis or direct observation of the person in their natural setting (observational functional assessment).

These extra methods offer more impartial and supporting data to validate the behavior's intended purpose.

To summarize, FAST can be a helpful screening tool for collecting preliminary information about problematic behaviors. However, it should be used in combination with other functional assessment techniques to create a thorough understanding of the behavior and inform successful intervention approaches. [7]

2.1. Benefits of the Function Analysis System Technique:

The development of a FAST diagram is a creative thought process which supports communication between team members.[7]

The development of a FAST diagram helps teams to:

- Develop a shared understanding of the project
- Identify missing functions.
- Define, simplify and clarify the problem.
- Organize and understand the relationships between functions.
- Identify the basic function of the project, process or product.
- Improve communication and consensus.
- Stimulate creativity.

2.2. Create a FAST Diagram

Three key questions are addressed in a FAST Diagram:

- How do you achieve this function?
- Why do you do this function?
- When you do this function, what other functions must you do?

The following diagram illustrates how a function is expanded in "How" and "Why" directions in a FAST diagram.

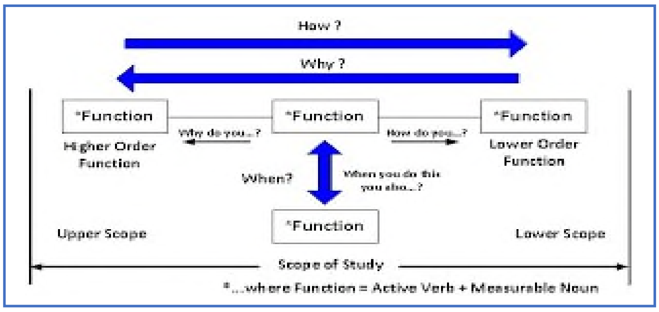

Figure I: FAST Diagram

2.3. Steps in constructing the FAST Diagram

Start with the Functions as identified using Function Analysis:[7]

- Expand the functions in the "How" and "Why" directions:
- Build along the "How" path by asking 'how is the function achieved'? Place the answer to the right in terms of an active verb and measurable noun.
- Test the logic in the direction of the "Why" path (right to left) by asking 'why is this function undertaken?'
- When the logic does not work, identify any missing or redundant functions or adjust the order.
- To identify functions that happen at the same time, ask "when this function is done, what else is done or caused by the function?"
- The higher order functions (functions towards the left on the FAST Diagram) describe what is being accomplished and lower order functions (functions towards the right on the FAST Diagram) describe how they are being accomplished.
- "When" does not refer to time as measured by a clock, but functions that occur together with or as a result of each other.

3. DESCRIPTION OF THE INTERNAL INTERVENTION PLAN (IIP)

Interventions in industrial safety play a crucial role in reducing workplace accidents and promoting safe behaviors among workers. Various studies have highlighted the effectiveness of safety intervention programs, such as the Theory of Planned Behavior (TPB) approach in rubberwood manufacturing [8], Safety Planning Intervention (SPI) for suicidal individuals , and government safety leadership interventions in reducing workplace accidents . These interventions typically involve elements like job safety analysis, safety standard operation procedures, training, campaigns, and consultations to enhance safety behaviors, lower accident rates, and create a safer work environment. Additionally, incorporating training sessions and educational software can further improve workers' understanding of safe behaviors and reduce human errors in high-risk industries like the petrochemical sector [4]. By implementing comprehensive intervention plans, organizations can effectively mitigate risks and prioritize the well-being of their employees.

The IIP is established to define the organization of relief and disaster response within a given industrial facility. It aims to protect the personnel, the public and the immediate environment and describes the measures to be taken to restore the safety of the facility and to prevent the disaster from becoming more widespread [9]. The IIP is based on the risk analysis. It defines the conditions for managing the accident and its consequences. It describes according to the major accident scenarios, the organization of the alert, the rescue and the response. More specifically, for each scenario, the IIP defines the strategy of the intervention, the first interventions, the course of the attack and the means required for each phase of the intervention. Risks of escalation of the disaster are identified, the action and precautions to be taken are reported.

- **Missions Considered in the IIP**

The IIP defines a 3-level emergency organization (the response teams, an Operational Command Post, an Internal Operations Management Post) set up internally to establish the interface with the other plans (PAM, ORSEC, Crisis, etc.) and also the various third parties involved in the accident. It specifies the structure of this organization, the exact role of each stakeholder and the hierarchical links between the different entities involved **[9].**

4. THE CHOSEN SYSTEM AND THEIR APPLICATION

4.1. Model studied

The considered system is a gas installation of three identical cylindrical tanks of section S. A schematic diagram of the considered system is shown in Figure (2). The tanks are coupled by two cylindrical connection pipes with a section Sn and a flow coefficient leaving $\mu_{13} = \mu_{32}$. The nominal outflow is located at tank 2, it also has a circular section Sn and an outflow coefficient μ_{20}.**[10]**

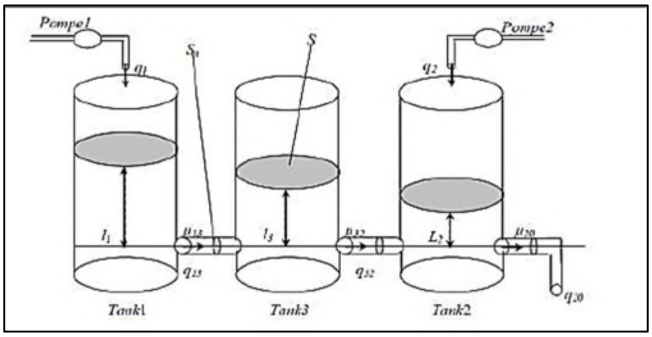

Figure 2: Three identical cylindrical tanks "Model studied"

Two pumps driven by DC motors supply reservoirs 1 and 2. Two D/A converters with a voltage range of -10 to +10 V are used to drive the pumps. The highest possible flow rate of pump i is denoted qimax . The variable L_j denotes the level in tank j, and Ljmax the highest possible level of liquid.**[11]**

product	liquid		flash point C°	boiling point C°	vapor pressure at 15C° (kg/m³)
	density at 15°c	vapor			
Butane C4+	0,58	2,49	-138	150	2,44

Table 1: characteristic of gas

4.2. Modeling of the IIP using the FAST approach:

We modeled the internal intervention plan using the FAST approach, which allowed a functional analysis of the IIP that is top-down, modular, hierarchical and structured. From the modeling of the IIP events, i.e., activities carried out by men and machines, we have shown the relationships that exist between them and the way they fit into a hierarchical structure when there is a major accident (alert) and the IIP is triggered, including:

- **Level 01 :**it shows a function global of the IIP and presents just the inputs, the outputs, the used resources and the possible constraints in a general way when the major accident is detected.
- **Level 02 :** this second established model depicts the global management process in the major incident. It shows how the three levels of safety barriers communicate with each other and how the first safety barrier (Level 1/IIP) communicates with the other levels during the exacerbation of their interference in the response.
- **Level 03 :**represents a hierarchical structural modeling of the IIP triggering when an alert/alarm occurs indicating an incident detection.

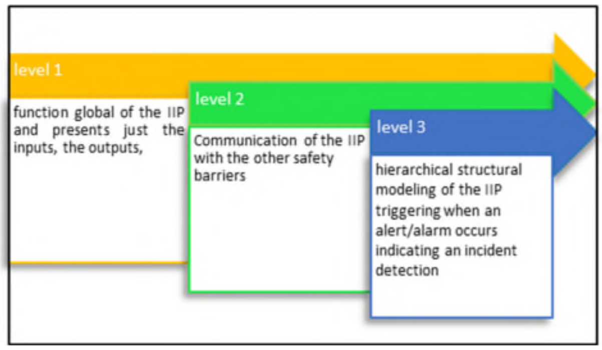

Figure 3: Modeling of the IIP using the FAST approach

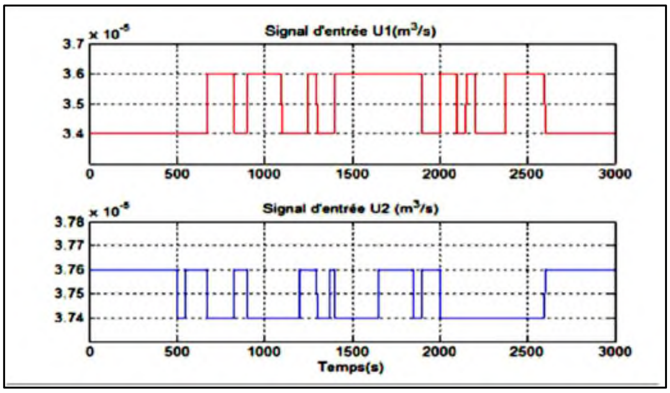

Figure 4 : Triggering the IIP

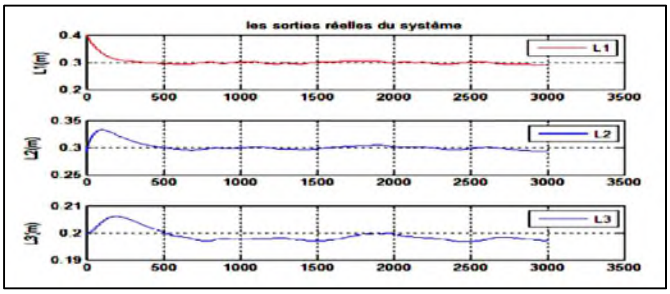

Figure 5: Situation under control

5. Conclusion

In this paper we proposed a coherent approach, based on a joint use of the FAST, in order to model a specific emergency response plan called Internal Intervention Plan (IIP) that is adopted in the Algerian gas industries. In fact, the modeling of the IIP allows its improvement before its execution in case of a major accident. Moreover, the proposed approach has been illustrated on a real major accident scenario related to a gas storage tank.

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NOMENCLATURE

IIP	Internal Intervention Plan
µ	Input
q	Speed