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# Bulletin MFRL

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**Inside the Issue**



**Recent Publications**

1. MZ Rizlan et al., Adv. Maters Processing Technol. 1-18, 2024.
2. Aimin, et al., Eng. Res. Express. 6, 032401, 2024.
3. AB Abdullah et al., Inter J Industrial Optimization. 106-117, 2024.

**Active Grants**

*FRGS Grant*
Title: Investigation on the effect of hot forging on the deformation behavior and microstructural response of Wire Arc Additive Manufacturing (WAAM) of high strength low alloy (HSLA) steel components, 2022-2026

## *Preface*

In the framework of modern smart manufacturing and to meet the IR 4.0 expectation, the topic of inline or real time process monitoring has gathered a lot of interest lately by industry and academia.

This is what has been the main topic of discussion during our revisit to Solid Precision Engineering Sdn. Bhd. Dr Boey's vision and aim on this issue get our attention.

Notice that the implementation may be a bit challenging as the cost involve a bit high and the requirement of multidisciplinary knowledge. With the high quality and productivity demands, exposure to the student about the technology is not anymore, an option. At the same time, research on this field needs a serious look.

## *Welcome to New Students*

On behalf of the group, I would like to welcome 3 new members, who just joined as a postgraduate student.

1. Muhammad Hafiz bin Muhammed Ali. A part time PhD student who was effective joined us in May 2024. He is a senior engineer at Inokom Corporation Sdn Bhd, Kulim. He in pursuing his study on the development of a new standard and quality control of portable spot-welding setup in automotive industry.

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2. Zarirah binti Karrim Wani. A part time MSc student who was effective joined us in May 2024. She is pursuing research at the MFRL on characterization of bi-metallic wire additive manufacturing. She is a full-time research officer at the School of Mechanical Engineering, USM.
3. Muhammad Faris Akmal is a returning student, who completed his master last year. His PhD project involve the tribological behavior of wire arc additive manufactured HSLA. He is under the FRGS project.

## *Keynote Speaker at FLAME 2024.*

It is an honour to be part of the conference and, together with researchers from various countries, share knowledge. At the conference, I was shared our latest research in the FSW and our findings. This is one of the research foci at the MFRL, and we are welcoming collaborators from any part of the world to be our research partners.



From my observation, researchers from India are very strong in FEM and other simulation tools. Most of the presenters shared their research on the application or development of FE tools in various applications.
My first experience to go oversea and present in a conference as a keynote speaker is a new milestone to me as an academia. Interestingly, this is also the first time in India. Thank you to the organizer of FLAME 2024 for inviting me to the conference. AMITY University is one of the private universities in Noida, Uttar Pradesh. The conference is organized by the Department of Mechanical Engineering, headed By Prof Basant.

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**Smart Tooling in Metal Bending Process**

By Ahmad Baharuddin Abdullah

**Definition**

Smart tooling can be described as a technology that allows for remote control and monitoring of any metal forming processes. There are many advantages offered by smart tooling including real-time monitoring, quick identification and alteration without physical presence. The tool is embedded with sensors to ensure the raw material is handled appropriately until its final shape.

Tube bending is one of the metals forming processes that can benefit from the application of smart tooling. Tube bending setup in general consist of stationary bend die, compression die and bender as shown in Figure 1. Typically, mandrel will be used to avoid tube defects.

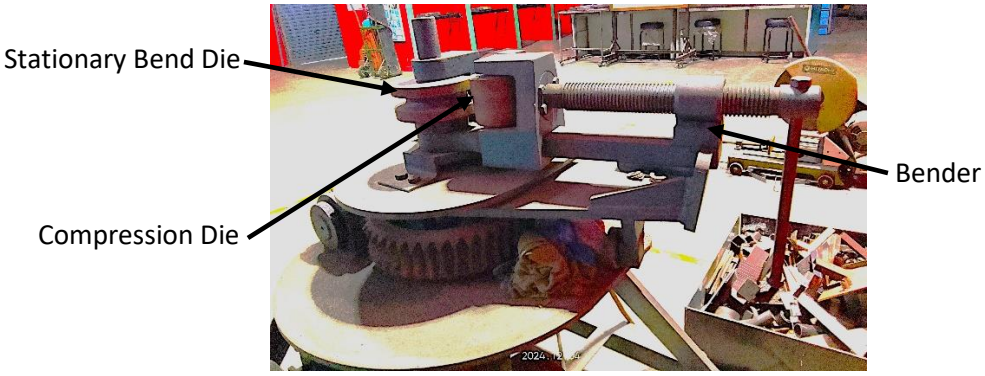


Figure 1

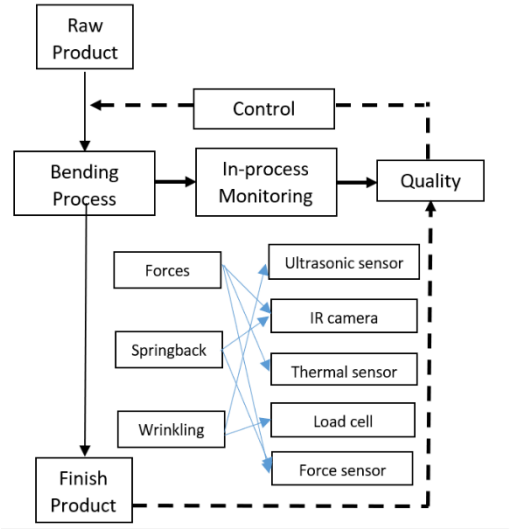


Figure 2

**Area of Interest**

From literature, there are various types of indicators that has been measured using various devices and methods as summarized in Table 1.

In a typical bending process, the quality of the finished product may be assessed after the product is manufactured. In-line or real time monitoring, the quality of the product can be inspected and controlled during the process. This will give advantages to the production line, not just by ensuring the process is of high quality and at the same time the process can be performed without operators present.

In the case of tube bending process, usually there are elements that need to be controlled. In terms of defect, springback and wrinkling are the most common. Researchers found that these two types of defects spoiled the most bent tube. Furthermore, forces applied during bending also need to be controlled, however it requires expensive setup.

However, two more potential categories to be considered are safety and process flow. Safety not only on the operator, but also on machine and die. While on process flow aspect, the system will ensure supply of raw material remain continuous, correct size and most importantly no shortage.

Table 1.

| Category | Measure | Device | Reference |
|---|---|---|---|
| Measurement | Force | embedded force sensors in the die | He et al., (2024) |
| | | Load cells | Borchmann et al. (2020) |
| | Pressure | Pressure gauge | Safdarian and Kord (2019) |
| Defect | Springback | laser tracking | Ha et al., (2022) |
| | | Torque measurement | Welo and Granly (2010) |
| | | Point tracking using IR-camera | Scandola et al., (2024) |
| | Wrinkling | Laser sensors | Borchmann et al. (2020) |

References

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Ha, T., Welo, T., Ringen, G. *et al.* A strategy for on-machine springback measurement in rotary draw bending using digital image-based laser tracking. *Int J Adv Manuf Technol* **119**, 705–718 (2022).

Borchmann L, Frohn-Sörensen P, Engel B (2020) In situ detection and control of wrinkle formation during rotary draw bending. Procedia Manuf 50:589–596.

Welo T, Granly B (2010) A new adaptive bending method using closed loop feedback control. Trans Nonferrous Met Soc China 20:2111–2117.

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Lorenzo Scandola, Viktor Böhm, Daniel Maier, Jeremias Tschannerl, Florian Steinlehner, Christoph Hartmann, Wolfram Volk, An inline point-tracking approach for the real-time monitoring of the free-form bending process, Advances in Industrial and Manufacturing Engineering, 9, 2024, 100150.