

Design of an automated buffer system with a loading and unloading system for an encapsulation machine

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Bridging programme for Master of Electromechanical Engineering Technology

Objective

Bluefoot Membranes specializes in producing **3D-filters** that are used for purifying process water and as a treatment step in drinking water filtration. Currently, the manufacturing process is carried out manually by an operator. Elmech is designing a machine to automate the casting process for Bluefoot Membranes. This bachelor's thesis focuses on the **automatic system for the machine's infeed and outfeed buffering**.

An operator secures the **3D-textile onto a steel frame** and places it inside the **infeed buffer**. This buffer feeds loaded frames to the casting process using its connected **loading system**. This casting process encapsulates the textile in a liquid polymer. The encapsulated textile is then immersed in a heated bath for a specific duration to undergo hardening, a process known as coagulation, which forms the 3D-filter. After this, the **unloading system** separates the filter from the frame. The filter is directed into a post-processing bin, while the empty frame is stored in the **outfeed buffer**. The outfeed buffer provides the operator with empty frames to ensure the **process runs continuously**.

The complete design of this machine would be too extensive to design for this bachelor's thesis. Therefore, some parts of this machine have been excluded from this project.

This machine aims **to improve production consistency and operator safety**. It may be possible for two of these setups to run in parallel, with one employee operating both machines. This could **drastically increase production speed**.

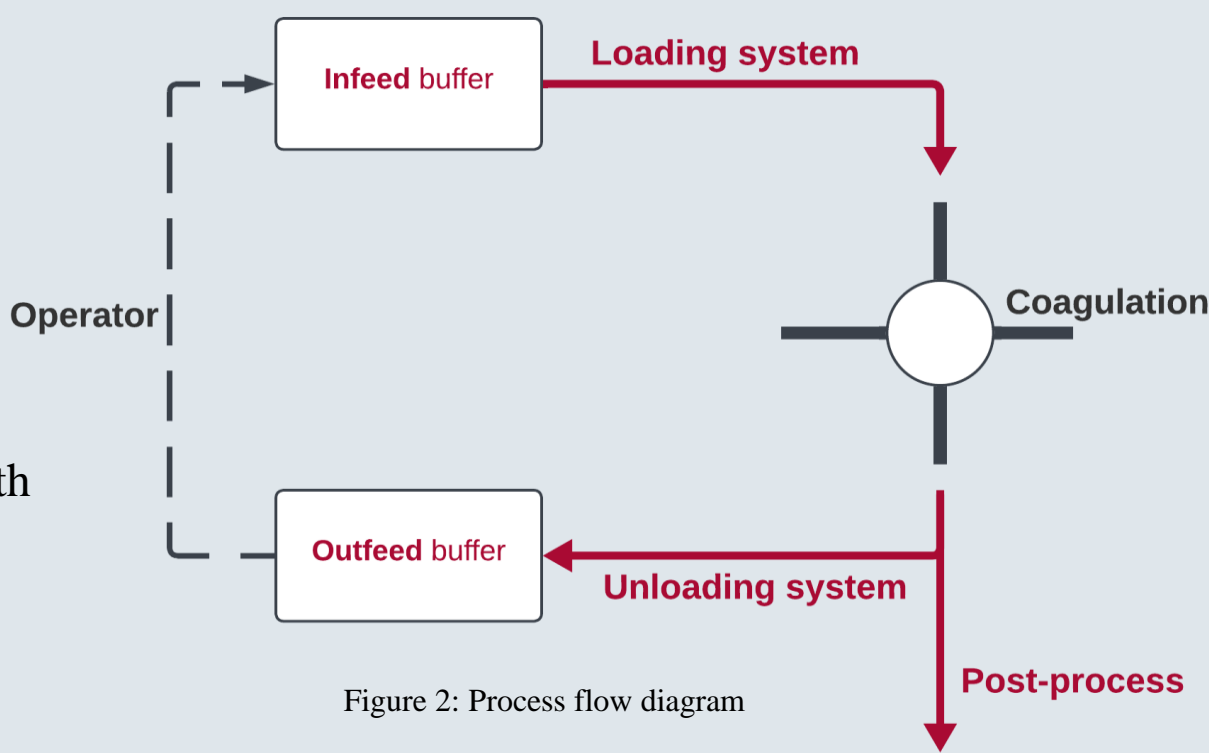


Figure 2: Process flow diagram

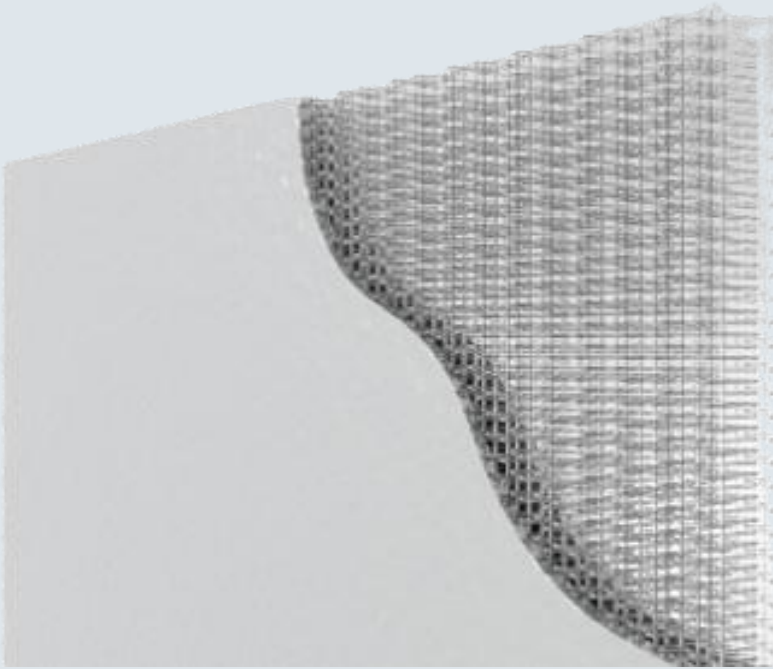


Figure 1: 3D-textile encapsulated in polymer

Augmented Reality

1. Scan the QR-code.
2. Download the Vuforia View app.
3. Using this app, scan the cube logo.
4. Experience our design in augmented reality!



1. Infeed buffer

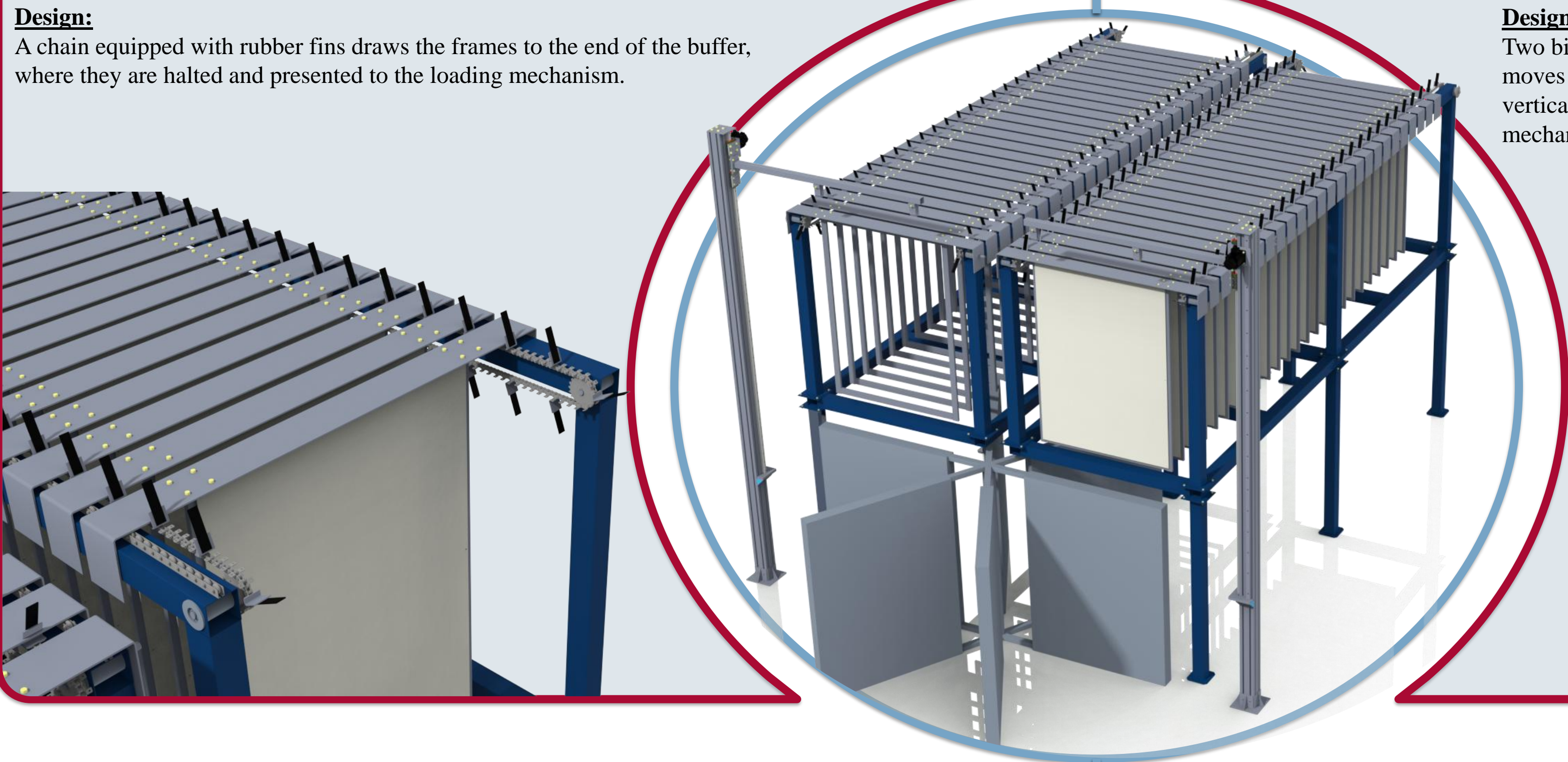
An **automatic resupply of frames loaded with 3D-textile to the machine**. The rails supporting the empty frame for assisting the operator are not designed for this project.

Requirements:

- Holds **room for 25 filled frames**.
- **Uninterruptible loading** of filled frames by the operator is required.
- Filled frames must be **automatically queued** to the loading system; no idle time is allowed.

Design:

A chain equipped with rubber fins draws the frames to the end of the buffer, where they are halted and presented to the loading mechanism.



2. Loading system & Coagulation

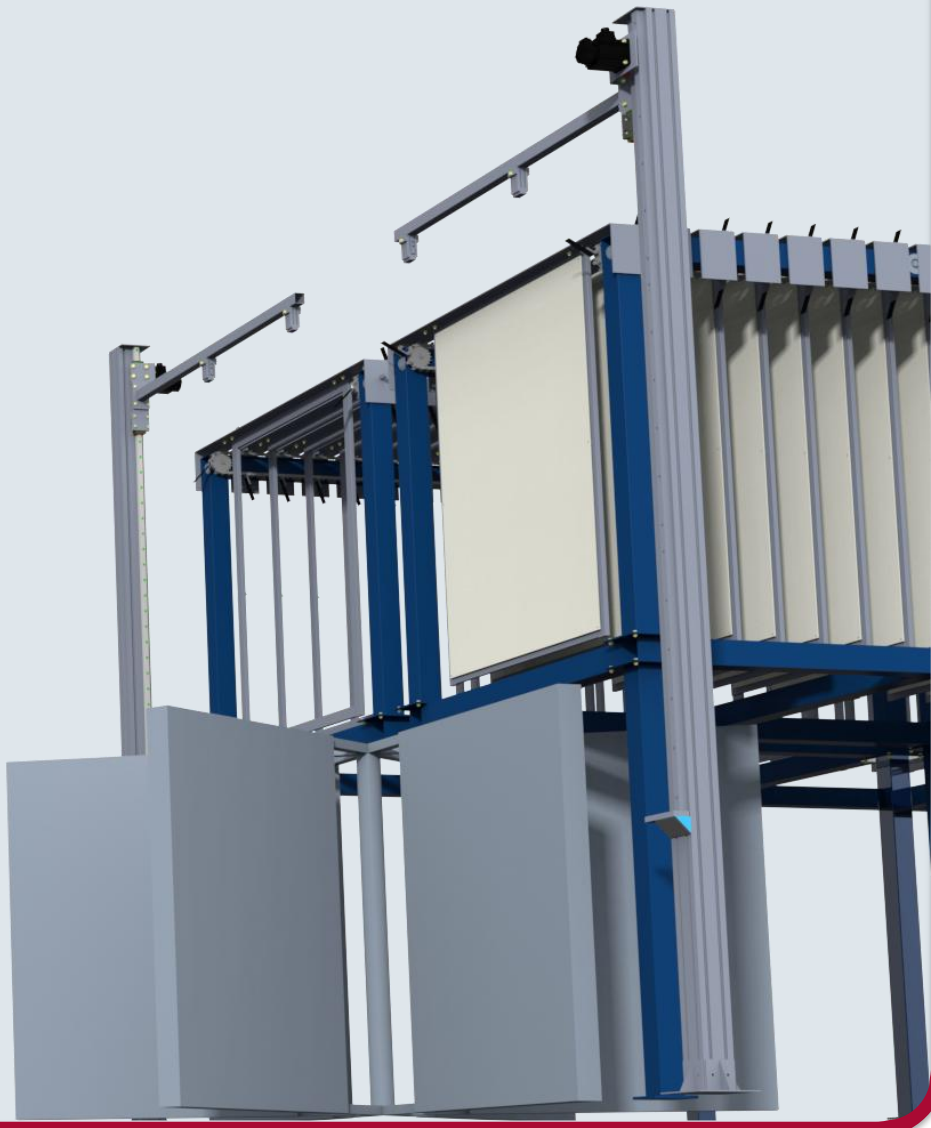
The loading system **lowers the frames into the coagulation bins**. During this, the polymer is cast around the 3D-textile. The coagulation component of this machine is excluded from this project. The coagulation process utilizes a carousel mechanism, depicted in a simplified representation.

Requirements:

- Theoretical **payload of 100 kg**.
- **Variable and controlled lowering speed** for the encapsulation process; 0,5 – 2 m/min.
- Maximum **changeover time of 5s**.

Design:

Two bi-stable magnets are mounted on a lift consisting of a cart that moves along a linear guide connected to an aluminum profile. The vertical motion is provided by a motor attached to a rack and pinion mechanism.

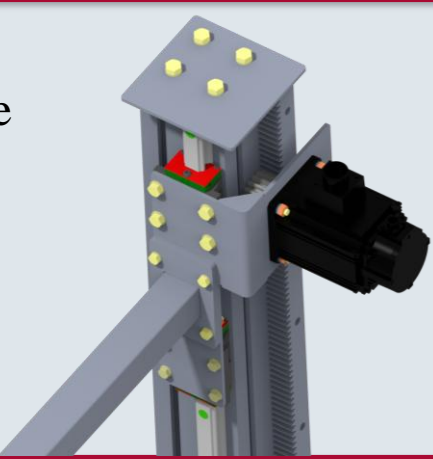


3. Unloading system & Post-process

The unloading system consists of two mechanisms: first, a similar lift used in the loading system; and second, a pull-off mechanism that separates the filter from the frame. The pull-off mechanism is excluded from this project.

Requirements:

- Theoretical **payload of 100 kg**.
- **Safe separation** of the filter from the steel frame
- Maximum **changeover time of 5s**.

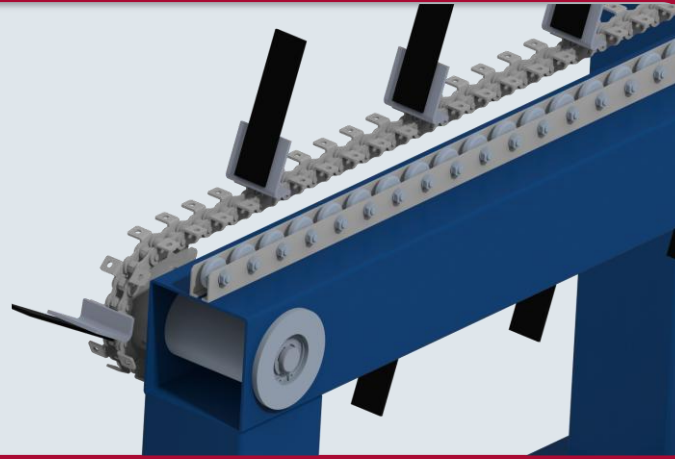


4. Outfeed buffer

An **automatic resupply of empty frames to the operator**, while simultaneously being filled by the unloading system. The outfeed buffer employs similar mechanisms used in the infeed buffer.

Requirements:

- Holds **room for 25 empty frames**.
- Uninterruptible loading of empty frames by the unloading system
- Empty frames must be **automatically queued** to the operator.



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