This project aims to investigate the dynamics of beams coated with piezoelectric layers and supported by shear thickening fluids. By employing mathematical modeling, numerical analysis, experimental techniques, and analytical approaches, the research seeks to enhance the understanding and design of auto-adaptable vibratory devices that utilize beam-based structures. The project focuses on two main mechanisms: energy dissipation and energy harvesting, with the goal of making significant improvements in the design of such devices.

Energy dissipating mechanisms, including dampers, absorbers, and isolators, play a vital role in controlling vibrations. Dampers are specifically designed to reduce undesired vibrations and minimize motion, while absorbers are employed to modulate oscillations. Isolators, on the other hand, aim to isolate the main system from disruptive vibrations using auxiliary components like isolator springs or inertia blocks. These vibrational control systems find widespread application in various fields to prevent damage caused by disruptive vibrations, ensuring longevity of devices and creating safer and more comfortable conditions for users.

Energy harvesting mechanisms, utilized by vibrational energy harvesters, enable the collection of wasted vibrations from abundant ambient sources, making them environmentally friendly and sustainable energy systems. These devices leverage smart materials to convert different forms of energy, such as light and heat, into vibrations. By employing piezoelectric materials, vibrations can be efficiently transformed into electricity, the most practical and usable form of energy. Piezoelectric energy harvesting offers advantages like high power density, ease of implementation, and the ability to be fabricated at macro, micro, and nano scales.

Unfortunately, existing energy dissipating and harvesting mechanisms heavily rely on external power sources, resulting in various operational challenges. Notably, they encounter drawbacks such as additional expenses and, more critically, significant delays in their response time. The response time significantly impacts control performance, rendering it impractical for the ever-changing conditions that are regularly experienced.

Here, the proposal is to employ shear thickening fluids (STFs) at boundary conditions as a means to eliminate power output. STFs, classified as intelligent fluids, have not undergone extensive examination, particularly in this specific field. However, their unique characteristics can be harnessed and manipulated to achieve the desired dynamic behavior in our adaptable devices. Consequently, this approach not only eliminates the need for external power supply but also drastically reduces the adaptation time.

To facilitate the design process and ensure the appropriate selection of shear thickening fluids (STFs), initial structural systems were explored, yielding promising results. These findings were published in reputable scientific journals with significant impact factors. They revealed that STFs should be used on supports perpendicular to the beam direction and that a method (Galerkin method with non-uniform comparison function) could be used to have more accurate mathematical predictions. We strongly believe that this research endeavor has the potential to revolutionize the design of next-generation vibratory ”powerless” auto-adaptable devices operating well in a wide range of unexpected conditions.