Executive Summary: On-market treatment of spinal bone tumors irritates the spinal cord & organs, decreasing the quality of life for 200,000 patients. Spine-Rad™ Brachytherapy Bone Cement mixes radioactive powder (Phosphorus-32 Hydroxyapatite(P-32-HA)) with an FDA-approved bone cement to be injected into the patient’s spine to improve quality of life. This project is a powder dispensing device that snaps open a vial of the radioactive powder using a tungsten-carbide blade & disperses a user-specified amount of powder into a syringe using a screw conveyor & analytical balance, so that the radioactive powder can be mixed in with the bone cement to inject into patients. The team has finished designing and has begun to manufacture a proof of concept, leading into the initial prototype.

Procedure Overview:

1. Scoring & Snapping
   - Vial is rotated 360° by a flywheel and scored by a blade on the other side of the vial
   - Clamp wheel and flywheel rotate the ampoule while a downward force.
   - To score a glass ampoule 360° around, and to snap it open using a blade scores it. Clamp wheel rotating the vial hitting a fulcrum to cause the vial to break open.

2. P-32-HA Dispensing
   - Auger filler moves P-32-HA radioactive powder to a nozzle which will be dispensed into a syringe
   - Syringe containing the powder will be weighed by the electronic scale

Key Mechanical Components:

- **Weigh/Dispense**
  - Purpose: Accurately dispense 14-340 mg of powder into a 30mL syringe
  - Technique: Horizontal screw conveyor and needle

- **Snap/Score**
  - Purpose: To score a glass ampoule 360° around, and to snap it open using a blade scores it.
  - Technique: Clamp wheel and flywheel

Key Electronic Components:

- **Microcontroller**
  - Used to control all motors & actuators, thus requiring precise response time

- **Auger Screw Servo**
  - Requires precise positioning and high torque in order to snap the glass vial

- **Pusher Solenoid**
  - Requires linear motion (stroke length: 4.5mm) to prevent lumps of powder

- **Clamp Wheel Servo**
  - Requires 360° rotation and precise positioning to dispense P-32-HA powder

Conclusion:

(1) **Proof of Concept**: Electrical & mechanical component functionality
(2) **Project Timeline & Future Improvements**: Part of the concept generation for the snap/score solution was done prior to MAE151A in Winter 2024; the team will create an improved prototype which will improve system geometry & integration, as well as refine the electronic components used
(3) **Societal & Environmental Impact**: Being able to implement this design will improve 200K patients’ lives, however, a major environmental roadblock of disposing the glass vial fragments and radiation waste remains