CLAIMS

1. A delivery apparatus for a prosthetic heart valve, the delivery apparatus comprising:

a handle having a proximal end, a distal end, and a cavity extending from the proximal end to the distal end;

a plurality of actuation assemblies, each of the actuation assemblies comprising a movable portion, each movable portion having a proximal end portion disposed within the cavity and a distal end portion disposed outside of the cavity;

a plate member disposed within the cavity and axially movable relative to the handle, the plate member having a first state in which the plate member moves freely relative to the movable portions and a second state in which the plate member engages the movable portions such that further axial movement of the plate member results in axial displacement of the movable portions; and

a drive assembly operatively coupled to the plate member and operable to move the plate member axially relative to the handle.

2. The delivery apparatus of claim 1, wherein each of the movable portions comprises an actuation tube and an actuation member extending through and coupled to the actuation tube, and wherein the plate member is positioned distal to the actuation tubes such that axial movement of the plate member in a direction towards the proximal end of the handle results in contact between the plate member and the actuation tubes.

3. The delivery apparatus of claim 2, wherein the plate member comprises a plurality of slots for passage of the actuation members.

4. The delivery apparatus of either claim 2 or claim 3, wherein the drive assembly comprises a driving gear operatively engaged with a first driven gear, and wherein the first driven gear is coupled to the plate member such that rotation of the driving gear results in axial movement of the plate member relative to the handle.

5. The delivery apparatus of claim 4, wherein the drive assembly further comprises a plurality of second driven gears operatively engaged with the driving gear, each of the second driven gears coupled to one of the actuation tubes such that rotation of the driving gear results in rotation of the actuation members.

6. The delivery apparatus of claim 5, further comprising a first rotatable knob coupled to the driving gear, wherein rotation of the first rotatable knob results in rotation of the driving gear.

7. The delivery apparatus of any one of claims 2 to 6, further comprising a second rotatable knob coupled to the actuation members and the handle, wherein rotation of the second rotatable knob in a first direction applies a pull force to the actuation members and rotation of the second rotatable knob in a second direction that is opposite to the first direction releases the pull force from the actuation members.

8. The delivery apparatus of claim 7, further comprising a pull force mechanism, the pull force mechanism comprising a reel coupled to the second rotatable knob and to one of the actuation members, wherein the reel applies the pull force from the second rotatable knob to the one of the actuation members.

9. The delivery apparatus of claim 8, wherein the pull force mechanism further comprises one or more pulleys arranged to distribute the pull force applied to the one of the actuation members uniformly among the actuation members.

10. The delivery apparatus of either claim 8 or claim 9, wherein each actuation member comprises a threaded head, an actuation flexible portion, and an actuation torque-transferring portion extending between the threaded head and the actuation flexible portion, and wherein the actuation flexible portion of the one of the actuation members is attached to the reel.

11. The delivery apparatus of any one of claims 8 to 10, further comprising a tensioning assembly coupled to the one of the actuation members, the tensioning assembly comprising a spring member arranged to apply tension to the one of the actuation members.

12. The delivery apparatus of any one of claims 2 to 11, further comprising:

a first sensor member coupled to at least one of the actuation members and rotatable with the at least one of the actuation members;

a second sensor member positioned to detect changes in a rotational position of the first sensor member; and

circuitry to count a number of rotations of the at least one of the actuation members from an output of the second sensor member, wherein the circuitry outputs an indication in response to the number of rotations of the at least one of the actuation members exceeding a predetermined threshold.

13. The delivery apparatus of any one of claims 2 to 12, further comprising a shaft assembly coupled to the handle, wherein the shaft assembly comprises:

a first shaft axially movable relative to the handle, the first shaft having a first lumen; and

a second shaft extending through the first lumen, the second shaft having one or more second lumens, wherein the actuation members extend through the one or more second lumens.

14. The delivery apparatus of claim 13, further comprising:

a third shaft extending through one of the one or more second lumens, the third shaft having a proximal end portion extending into the cavity, a distal end portion disposed outside the cavity, and a third lumen; and

a nosecone coupled to the distal end portion of the third shaft, the nosecone having a central opening aligned with the third lumen for passage of a guidewire.

15. A delivery assembly comprising:

the delivery apparatus of any one of claims 1-14; and

a mechanically-expandable prosthetic heart valve comprising a plurality of actuators operable to adjust a diameter of the prosthetic heart valve,

wherein the movable portions of the actuation assemblies are releasably coupled to the plurality of actuators and axially movable to operate the plurality of actuators.