CLAIMS

1. A delivery assembly for performing an autonomous tubular operation, comprising:

an elongated canister;

at least one actuatable tool;

a location device for sensing the location of the at least one actuatable tool within a tubular body based on a physical signature provided along the tubular body; and

an on-board controller configured to send an actuation signal to at least one of the at least one actuatable tool when the location device has recognized a selected location of the actuatable tool based on the physical signature;

wherein:

the canister, the location device, and the on-board controller are together dimensioned and arranged to be deployed in the tubular body as an autonomous unit; and

the delivery assembly is designed to release a material from the canister in response to a release signal.

2. The delivery assembly of claim 1, wherein the tubular body is (i) a wellbore constructed to produce hydrocarbon fluids, (ii) a wellbore constructed to inject fluids into a subsurface formation, or (iii) a pipeline containing fluids.

3. The delivery assembly of claim 1, wherein:

the location device is a radio frequency antenna; and

the signature is formed by the spacing of identification tags along the tubular body, with the identification tags being sensed by the radio frequency antenna.

4. The delivery assembly of claim 1, wherein:

the tubular body is a wellbore;

the location device is a casing collar locator; and

the signature is formed by the spacing of collars along the tubular body, with the collars being sensed by the collar locator.

5. The delivery assembly of claim 4, wherein:

the location device comprises a pair of sensing devices spaced apart along the delivery assembly as lower and upper sensing devices;

the controller comprises a clock that determines time that elapses between sensing by the lower sensing device and sensing by the upper sensing device as the delivery assembly traverses across a collar; and

the delivery assembly is programmed to determine delivery assembly velocity at a given time based on the distance between the lower and upper sensing devices, divided by the elapsed time between sensing.

6. The delivery assembly of claim 5, wherein a position of the actuatable tool at the selected location along the wellbore is confirmed by a combination of (i) location of the delivery assembly relative to the collars as sensed by either the lower or the upper sensing device, and (ii) velocity of the delivery assembly as computed by the controller as a function of time.

7. The delivery assembly of claim 4, wherein:

the delivery assembly further comprises a set of slips for holding the location of the delivery assembly proximate the selected location; and

one of the at least one actuatable tool comprises the set of slips, such that the set of slips is activated at the selected location in response to the actuation signal.

8. The delivery assembly of claim 7, wherein:

the delivery assembly further comprises an elastomeric sealing element for sealing the tubular body; and

the actuatable tool further comprises the sealing element, such that the sealing element is also activated at the selected location in response to the actuation signal.

9. The delivery assembly of claim 1, wherein:

the elongated canister is a fluid container; and

the delivery assembly is designed to release fluid from the fluid container in response to a release signal.

10. The delivery assembly of claim 9, wherein:

the fluid container contains a fluid; and

the fluid comprises (i) air loaded into the chamber at substantially atmospheric pressure, (ii) a resin, (iii) an acid, (iv) a surfactant, (v) a hydrate inhibitor, (vi) oxygen, or (vi) a fluid selected to expedite the swelling of a swellable packer.

11. The delivery assembly of claim 10, wherein:

the actuatable tool comprises a detonator, such that activation of the detonator causes a release of fluid from the fluid container at the selected location;

the fluid delivery assembly is fabricated from a friable material;

the fluid delivery assembly is designed to self-destruct in response to a detonation signal sent to the detonator; and

the detonation signal is also the release signal.

12. The delivery assembly of claim 10, wherein:

the fluid container comprises a valve having at least one port;

one of the at least one actuatable tool comprises the valve; and

the valve is configured to open the at least one port in response to the release signal sent from the on-board controller.

13. The delivery assembly of claim 12, wherein:

the fluid container is fabricated from a friable material; and

the delivery assembly is constructed to self-destruct in response to the actuation signal.

14. The delivery assembly of claim 13, wherein the controller is programmed to send the release signal before the actuation signal.

15. The delivery assembly of claim 13, wherein:

destruction of the canister causes a release of the fluid such that the actuation signal and the release signal are the same signal.

16. The delivery assembly of claim 1, wherein:

the material in the elongated canister comprises substantially solid material; and

the delivery assembly is designed to release the solid from the canister in response to the release signal.

17. The delivery assembly of claim 16, wherein:

the canister is fabricated from a friable material; and

the delivery assembly is constructed to self-destruct in response to the actuation signal.

18. The delivery assembly of claim 16, wherein the controller is programmed to send the release signal before the actuation signal.

19. The delivery assembly of claim 18, wherein:

the delivery assembly further comprises a perforation gun for perforating a string of casing proximate the selected location;

one of the at least one actuatable tool comprises the perforating gun, such that perforating charges are fired at the selected location in response to the actuation signal; and

the controller is programmed to send the release signal before the actuation signal.

20. The delivery assembly of claim 18, wherein the solid material comprises ball sealers that are dimensioned to seal perforations.

21. The delivery assembly of claim 17, wherein destruction of the canister causes a release of the solid material such that the actuation signal and the release signal are the same signal.

22. The delivery assembly of claim 1, further comprising:

a battery pack; and

a multi-gate safety system for preventing premature activation of the at least one actuatable tool, the safety system comprising control circuitry having one or more electrical switches that are independently operated in response to separate conditions before permitting the actuation signal to reach the tool.

23. The delivery assembly of claim 22, wherein the multi-gate safety system comprises at least one of:

(i) a selectively removable battery pack, wherein the control circuitry is configured to operate an electrical switch when the battery pack is installed into the assembly;

(ii) a mechanical pull-tab, wherein the control circuitry is configured to operate an electrical switch upon removal of the tab from the fluid delivery assembly;

(iii) a pressure-sensitive switch that is configured to operate an electrical switch only when a designated hydraulic pressure on the fluid delivery assembly is exceeded;

(iv) an electrical timer switch that is configured to operate only a designated period of time after deployment of the fluid delivery assembly in the wellbore;

(v) a velocity sensor configured to operate an electrical switch only upon sensing that the fluid delivery assembly is traveling a designated velocity; and

(vi) a vertical sensor configured to operate an electrical switch when the fluid delivery assembly is substantially vertical;

wherein operating an electrical switch means either closing such a switch to permit a flow of electrical current through the switch and toward the actuatable tool, or opening such a switch to restrict a flow of electrical current through the switch and toward the actuatable tool.

24. The delivery assembly of claim 1, further comprising:

a whipstock mechanically connected to the actuatable tool wherein:

the actuatable tool, the whipstock, the location device, and the on-board controller are together dimensioned and arranged to be deployed in the wellbore as an autonomous unit; and

the actuatable tool is designed to be actuated in response to the actuation signal.

25. The delivery assembly of claim 24, wherein the whipstock assembly further comprises:

an accelerometer in electrical communication with the on-board controller to confirm the selected location of the whipstock assembly.

26. A method for delivering fluid to a subsurface formation, comprising:

releasing a fluid delivery assembly into a wellbore, the fluid delivery assembly comprising:

an elongated fluid container containing a fluid,

at least one actuatable tool;

a location device for sensing the location of the at least one actuatable tool within a tubular body based on a physical signature provided along the tubular body, and

an on-board controller configured to send an actuation signal to at least one of the at least one actuatable tool when the location device has recognized a selected location of the actuatable tool based on the physical signature;

wherein the fluid container, the location device, the at least one actuatable tool, and the on-board controller are together dimensioned and arranged to be deployed in the wellbore as an autonomous unit; and

releasing fluid from the fluid container at the selected location in response to a release signal.

27. The method of claim 26, wherein:

the location device is a radio frequency antenna; and

the signature is formed by the spacing of identification tags along the tubular body, with the identification tags being sensed by the radio frequency antenna.

28. The method of claim 26, wherein:

the location device is a collar locator; and

the signature is formed by the spacing of casing collars along the wellbore, with the collars being sensed by the collar locator.

29. The method of claim 28, wherein:

the location device comprises a pair of sensing devices spaced apart along the fluid delivery assembly as lower and upper sensing devices;

the signature is formed by the placement of tags spaced along the wellbore that are sensed by each of the sensing devices;

the controller comprises a clock that determines time that elapses between sensing by the lower sensing device and sensing by the upper sensing device as the fluid delivery assembly traverses across a tag; and

the fluid delivery assembly is programmed to determine fluid delivery assembly velocity at a given time based on the distance between the lower and upper sensing devices, divided by the elapsed time between sensing.

30. The method of claim 29, wherein a position of the fluid delivery assembly at the selected location along the wellbore is confirmed by a combination of (i) location of the fluid delivery assembly relative to the tags as sensed by either the lower or the upper sensing device, and (ii) velocity of the fluid delivery assembly as computed by the controller as a function of time.

31. The method of claim 26, wherein:

the fluid delivery assembly is fabricated from a friable material; and

the fluid delivery assembly is designed to self-destruct in response to a detonation signal.

32. The method of claim 31, wherein the at least one actuatable tool comprises a detonator, such that activation of the detonator causes the self-destruction of the fluid container; and a release of fluid from the fluid container at the selected location.

33. The method of claim 31, wherein:

the release signal serves to open a valve, thereby releasing fluid from the fluid container at the selected location; and

the release signal is sent prior to the detonation signal.

34. The method of claim 26, wherein:

the fluid delivery assembly further comprises a set of slips for holding the location of the fluid delivery assembly proximate the selected location;

the actuatable tool comprises the set of slips, such that the set of slips is activated in response to the actuation signal.

35. The method of claim 34, further comprising:

sending a signal to release the slips; and

retrieving the fluid delivery assembly from the wellbore.

36. The method of claim 35, wherein sending a signal comprises (i) sending an electrical signal from the on-board controller, or (ii) sending an acoustic signal through hydraulic pulses delivered from a surface.

37. The method of claim 34, wherein:

the fluid delivery assembly further comprises an elastomeric sealing element for sealing the tubular body; and

the actuatable tool further comprises the sealing element, such that the sealing element is also activated in response to the actuation signal.

38. The method of claim 26, wherein the fluid comprises (i) air loaded into the chamber at substantially atmospheric pressure, (ii) a resin, (iii) an acid, (iv) a surfactant, (v) a hydrate inhibitor, (vi) oxygen, or (vii) a fluid selected to expedite the swelling of a swellable packer.

39. The method of claim 26, wherein:

the fluid container comprises a valve having at least one flow port;

one of the at least one actuatable tool comprises the valve; and

the method further comprises activating the valve to open the at least one flow port in response to the release signal to release the fluid from the fluid container.

40. The method of claim 39, wherein:

the fluid container is fabricated from a friable material; and

the fluid delivery assembly is constructed to self-destruct at the time, or a designated period of time after, the at least one flow port has been opened.

41. The method of claim 26, wherein:

the on-board controller is part of an electronic module comprising onboard memory and built-in logic; and

the electronic module is configured to send a signal that initiates detonation of the detonator after the valve has been opened.

42. The method of claim 41, wherein the built-in logic provides a digital safety barrier based on a predetermined value for (i) assembly depth, (ii) assembly speed, (iii) travel time, (iv) downhole markers, or (v) combinations thereof.

43. The method of claim 26, wherein the fluid comprises air and a solid material.

44. The method of claim 43, wherein the solid material comprises at least one of a biodegradable diverter, an ignitable material, ball sealers, benzoic acid flakes, particulates, and a cellulosic material.

45. A method for forming a window through a string of casing within a wellbore, comprising:

releasing a whipstock assembly into the wellbore, the whipstock assembly comprising:

at least one actuatable tool,

a whipstock mechanically connected to the actuatable tool,

a location device for sensing the location of the actuatable tool within a wellbore based on a physical signature provided along the wellbore, and

an on-board controller configured to send an actuation signal to the tool when the location device has recognized a selected location of the actuatable tool based on the physical signature,

wherein the at least one actuatable tool, the whipstock, the location device, and the on-board controller are together dimensioned and arranged to be deployed in the wellbore as an autonomous unit;

setting the whipstock assembly at the selected location in response to the actuation signal;

running a milling bit into the wellbore; and

rotating the milling bit in order to form a window through the casing adjacent the whipstock.

CLAIMS

1. A delivery assembly for performing an autonomous tubular operation comprising:

an elongated canister;

at least one actuatable tool;

a location device for sensing the location of the at least one actuatable tool within a tubular body based on a physical signature provided along the tubular body; and

an on-board controller configured to send an actuation signal to at least one of the at least one actuatable tool when the location device has recognized a selected location of the actuatable tool based on the physical signature;

wherein:

the canister, the location device, and the on-board controller are together dimensioned and arranged to be deployed in the tubular body as an autonomous unit;

the delivery assembly is designed to release a material from the canister in response to a release signal; and

the delivery assembly is constructed to self-destruct in response to the actuation signal.

2. The delivery assembly of claim 1, wherein the tubular body is (i) a wellbore constructed to produce hydrocarbon fluids, (ii) a wellbore constructed to inject fluids into a subsurface formation, or (iii) a pipeline containing fluids.

3. The delivery assembly claim 1or 2, wherein:

the elongated canister is a fluid container; and

the delivery assembly is designed to release fluid from the fluid container in response to a release signal.

4. The delivery assembly of claim 3, wherein:

the actuatable tool comprises a detonator, such that activation of the detonator causes a release of fluid from the fluid container at the selected location;

the fluid delivery assembly is fabricated from a friable material;

the fluid delivery assembly is designed to self-destruct in response to a detonation signal sent to the detonator; and

the detonation signal is also the release signal.

5. The delivery assembly of any one of claims 1 to 3, wherein:

the canister is fabricated from a friable material.

6. The delivery assembly of any one of claims 3 to 5, wherein one or more of (i) the controller is programmed to send the release signal before the actuation signal; (ii) when the canister is a fluid container, destruction of the canister causes a release of fluid such that the actuation signal and the release signal are the same signal; (iii) the material in the elongated canister comprises substantially solid material and the delivery assembly is designed to release the solid from the canister in response to the release signal; and (iv) destruction of the canister causes a release of the solid material such that the actuation signal and the release signal are the same signal.

7. The delivery assembly of claim 6, wherein:

the delivery assembly further comprises a perforation gun for perforating a string of casing proximate the selected location;

one of the at least one actuatable tool comprises the perforating gun, such that perforating charges are fired at the selected location in response to the actuation signal; and

the controller is programmed to send the release signal before the actuation signal.

8. The delivery assembly of claim 6, wherein the solid material comprises ball sealers that are dimensioned to seal perforations.

9. The delivery assembly of any one of claims 1 to 8, further comprising:

a battery pack; and

a multi-gate safety system for preventing premature activation of the at least one actuatable tool, the safety system comprising control circuitry having

one or more electrical switches that are independently operated in response to separate conditions before permitting the actuation signal to reach the tool.

10. The delivery assembly of claim 9, wherein the multi-gate safety system comprises at least one of:

i) a selectively removable battery pack, wherein the control circuitry is configured to operate an electrical switch when the battery pack is installed into the assembly;

ii) a mechanical pull-tab, wherein the control circuitry is configured to operate an electrical switch upon removal of the tab from the fluid delivery assembly;

iii) a pressure-sensitive switch that is configured to operate an electrical switch only when a designated hydraulic pressure on the fluid delivery assembly is exceeded;

iv) an electrical timer switch that is configured to operate only a designated period of time after deployment of the fluid delivery assembly in the wellbore;

v) a velocity sensor configured to operate an electrical switch only upon sensing that the fluid delivery assembly is traveling a designated velocity; and

vi) a vertical sensor configured to operate an electrical switch when the fluid delivery assembly is substantially vertical;

wherein operating an electrical switch means either closing such a switch to permit a flow of electrical current through the switch and toward the actuatable tool, or opening such a switch to restrict a flow of electrical current through the switch and toward the actuatable tool.

11. The delivery assembly of any one of claims 1 to 10, further comprising:

a whipstock mechanically connected to the actuatable tool wherein:

the actuatable tool, the whipstock, the location device, and the on-board controller are together dimensioned and arranged to be deployed in the wellbore as an autonomous unit; and

the actuatable tool is designed to be actuated in response to the actuation signal.

12. The delivery assembly of claim 11, wherein the whipstock assembly further comprises:

an accelerometer in electrical communication with the on-board controller to confirm the selected location of the whipstock assembly.

13. A method for delivering fluid to a subsurface formation, comprising:

releasing a fluid delivery assembly into a wellbore, the fluid delivery assembly comprising:

an elongated fluid container containing a fluid,

at least one actuatable tool;

a location device for sensing the location of the at least one actuatable tool within a tubular body based on a physical signature provided along the tubular body,

and

an on-board controller configured to send an actuation signal to at least one of the at least one actuatable tool when the location device has recognized a selected location of the actuatable tool based on the physical signature;

wherein the fluid container, the location device, the at least one actuatable tool, and the on-board controller are together dimensioned and arranged to be deployed in the wellbore as an autonomous unit; and

releasing fluid from the fluid container at the selected location in response to a release signal.

14. The method of claim 13 or the delivery assembly of claim 1 or 2, wherein:

the location device is a radio frequency antenna; and

the signature is formed by the spacing of identification tags along the tubular body, with the identification tags being sensed by the radio frequency antenna.

15. The method of claim 13 or delivery assembly of claim 1, wherein:

the location device is a collar locator; and

the signature is formed by the spacing of casing collars along the wellbore, with the collars being sensed by the collar locator.

16. The method or delivery assembly of claim 15, wherein:

the location device comprises a pair of sensing devices spaced apart along the fluid delivery assembly as lower and upper sensing devices;

the signature is formed by the placement of tags spaced along the wellbore that are sensed by each of the sensing devices;

the controller comprises a clock that determines time that elapses between sensing by the lower sensing device and sensing by the upper sensing device as the fluid delivery assembly traverses across a tag; and

the fluid delivery assembly is programmed to determine fluid delivery assembly velocity at a given time based on the distance between the lower and upper sensing devices, divided by the elapsed time between sensing.

17. The method or delivery assembly of claim 16, wherein a position of the fluid delivery assembly at the selected location along the wellbore is confirmed by a combination of (i) location of the fluid delivery assembly relative to the tags as sensed by either the lower or the upper sensing device, and (ii) velocity of the fluid delivery assembly as computed by the controller as a function of time.

18. The method of any one of claims 13 to 17, wherein:

the fluid delivery assembly is fabricated from a friable material; and the fluid delivery assembly is designed to self-destruct in response to a detonation signal.

19. The method of claim 19, wherein the at least one actuatable tool comprises a detonator, such that activation of the detonator causes the self-destruction of the fluid container; and a release of fluid from the fluid container at the selected location.

20. The method of claim 19, wherein:

the release signal serves to open a valve, thereby releasing fluid from the fluid container at the selected location; and

the release signal is sent prior to the detonation signal.

21. The delivery assembly of claim 1 or 2 or method of any one of claims 13 to 20, wherein:

the delivery assembly further comprises a set of slips for holding the location of the delivery assembly proximate the selected location;

one of the at least one actuatable tool comprises the set of slips, such that the set of slips is activated in response to the actuation signal.

22. The method of claim 21, further comprising:

sending a signal to release the slips; and

retrieving the fluid delivery assembly from the wellbore.

23. The method of claim 22, wherein sending a signal comprises co sending an electrical signal from the on-board controller, or (ii) sending an acoustic signal through hydraulic pulses delivered from a surface.

24. The delivery assembly of claim 1 or 2 or method of claim 21, wherein:

the fluid delivery assembly further comprises an elastomeric sealing element for sealing the tubular body; and

the actuatable tool further comprises the sealing element, such that the sealing element is also activated in response to the actuation signal.

25. The delivery assembly of claim 1 or 2 or method of any one of claims 13 to 24, wherein the fluid comprises (i) air loaded into the chamber at substantially atmospheric pressure, (ii) a resin, (iii) an acid, (iv) a surfactant, (v) a hydrate inhibitor, (vi) oxygen, or (vii) a fluid selected to expedite the swelling of a swellable packer.

26. The delivery assembly of claim 1 or 2 or method of claim 13, wherein:

the fluid container comprises a valve having at least one port;

one of the at least one actuatable tool comprises the valve; and

the valve is configured to open the at least one port in response to the release signal.

27. The method of claim 26, wherein:

the fluid container is fabricated from a friable material; and

the fluid delivery assembly is constructed to self-destruct at the time, or a designated period of time after, the at least one flow port has been opened.

28. The method of any one of claims 13 to 27, wherein:

the on-board controller is part of an electronic module comprising on board memory and built-in logic; and

the electronic module is configured to send a signal that initiates detonation of the detonator after the valve has been opened.

29. The method of claim 28, wherein the built-in logic provides a digital safety barrier based on a predetermined value for co assembly depth, (ii) assembly speed, (iii) travel time, (iv) down hole markers, or (v) combinations thereof.

30. The method of any one of claims 13 to 29, wherein the fluid comprises air and a solid material.

31. The method of claim 30, wherein the solid material comprises at least one of a biodegradable diverter, an ignitable material, ball sealers, benzoic acid flakes, particulates, and a cellulosic material.

32. A method for forming a window through a string of casing within a wellbore, comprising:

releasing a whipstock assembly into the wellbore, the whipstock assembly comprising:

at least one actuatable tool,

a whipstock mechanically connected to the actuatable tool,

a location device for sensing the location of the actuatable tool within a wellbore based on a physical signature provided along the wellbore, and

an on-board controller configured to send an actuation signal to the tool when the location device has recognized a selected location of the actuatable tool based on the physical signature,

wherein the at least one actuatable tool, the whipstock, the location device, and the on-board controller are together dimensioned and arranged to be deployed in the wellbore as an autonomous unit;

setting the whipstock assembly at the selected location in response to the actuation signal; and

the actuatable tool, location device, and the on-board controller are constructed to self-destruct in response to the actuation signal;

running a milling bit into the wellbore; and

rotating the milling bit in order to form a window through the casing adjacent the whipstock.