

The claims defining the invention are as follows:

1. An asset management system comprising:
a data storage arranged to store:
5 visual data indicative of a visual representation of an asset, the visual representation including visual representations of components of the asset;
component data indicative of characteristics of components of the asset including operational data indicative of operation of the components; and
10 spatial data including component location data indicative of location of the components relative to the asset in a first coordinate format according to a defined coordinate system;
a plurality of communication-enabled things disposed at the asset, each communication-enabled thing arranged to obtain operational data indicative of operation of at least one component of the asset and to communicate the operational
15 data to the data storage; and
a user interface arranged to facilitate access to the stored visual data, the user interface controllable by a user to display a visual representation of a selected portion of an asset, and to display visual representations of adjacent portions of the asset by receiving navigation instructions from the user;
20 wherein the user interface is arranged to facilitate display of component information adjacent a component as the user navigates through the visual representation of the asset, the component information derived from at least one communication-enabled thing associated with the component; and
wherein the spatial data includes actor location data indicative of location of at
25 least one actor disposed at the asset as the actor moves relative to the asset, the system arranged to obtain actor location data, and to store the actor location data in the first coordinate format.
2. An asset management system as claimed in claim 1, wherein the user interface
30 is arranged to automatically display component information adjacent a component as the user navigates through the visual representation of the asset when the visual representation of the component is displayed by the user interface.
3. An asset management system as claimed in claim 2, wherein the system is
35 arranged to display further component information in response to user input.

4. An asset management system as claimed in claim 1, wherein the user interface is arranged to display component information adjacent a component in response to user input when the visual representation of the component is displayed by the user interface.

5. An asset management system as claimed in claim 1, wherein at least some of the component information displayed adjacent a component is based on user defined criteria.

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6. An asset management system as claimed in any one of the preceding claims, wherein the component data includes data indicative of the type of component.

7. An asset management system as claimed in any one of the preceding claims, wherein the component data includes timing data associated with component operational data, the timing data indicative of the time at which operational data is obtained from a component.

8. An asset management system as claimed in claim 7, wherein the displayed component information includes the timing data.

9. An asset management system as claimed in any one of the preceding claims, wherein the displayed component information includes maintenance information.

10. An asset management system as claimed in any one of the preceding claims, wherein the user interface is arranged to display a time dependent visual representation of a portion of the asset and time dependent component information adjacent a component of the portion of the asset by facilitating selection of a time by a user.

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11. An asset management system as claimed in any one of the preceding claims, wherein the visual representation of the asset includes a visual representation of an actor at a location corresponding to the location of the actor at the asset.

12. An asset management system as claimed in any one of the preceding claims,

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wherein the component location data includes timing data indicative of the time at which a component is disposed at a location.

13. An asset management system as claimed in any one of the preceding claims,
5 wherein the actor location data includes timing data indicative of the time at which an actor is disposed at a location.

14. An asset management system as claimed in any one of the preceding claims,
10 wherein the actor comprises a geolocation device arranged to produce the actor location data indicative of the location of the actor relative to the asset.

15. An asset management system as claimed in claim 14, wherein the actor comprises a mobile computing device, the mobile computing device including the geolocation device.

16. An asset management system as claimed in any one of claims 1 to 13,
15 comprising a plurality of machine-readable markers disposed at distributed locations at the asset, wherein the actor includes a location device arranged to determine the location of the location device relative to the machine-readable markers and thereby
20 the location of the actor relative to the asset.

17. An asset as claimed in claim 16, wherein the machine-readable markers include visual location markers or Bluetooth beacons.

25 18. An asset as claimed in claim 14, wherein the geolocation device is arranged to determine the location of the actor relative to the asset using simultaneous localisation and mapping (SLAM) techniques.

19. An asset management system as claimed in any one of the preceding claims,
30 wherein the component data includes:

data indicative of audio;
data indicative of video;
data indicative of at least one image;
data indicative of vibration;
35 data indicative of temperature;

- data indicative of electrical current;
data indicative of flow rate;
data indicative of pressure;
data indicative of speed of movement;
5 data indicative of control values;
data indicative of equipment performance;
data indicative of position or state of a part of a component; and/or
data indicative of operational status (ON/OFF) of a component.
- 10 20. An asset management system as claimed in any one of the preceding claims,
wherein the plurality of communication-enabled things includes any one or more of:
a microphone;
a sensor;
a programmable logic controller (PLC) device.
- 15 21. An asset management system as claimed in any one of the preceding claims,
wherein the plurality of communication-enabled things includes a still and/or video
camera.
- 20 22. An asset management system as claimed in claim 21, wherein the spatial data
includes data indicative of the location shown in the field of view of the camera.
23. An asset management system as claimed in any one of the preceding claims,
wherein the user interface is arranged to automatically play audio associated with a
25 portion of the asset as the user navigates through the visual representation of the
asset and the portion of the asset is displayed, the audio derived from at least one
microphone.
24. An asset management system as claimed in any one of the preceding claims,
30 wherein each thing is incorporated into a component, connected to a component or
disposed adjacent the component.
25. An asset management system as claimed in any one of the preceding claims,
wherein the visual data indicative of a visual representation of an asset comprises
35 image data indicative of images of the asset, virtual representations indicative of the

asset, and/or point cloud data indicative of the asset.

26. An asset management system as claimed in claim 25, wherein the virtual representations comprise CAD representations.

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27. An asset management system as claimed in any one of the preceding claims, wherein the user interface uses a second coordinate format different to the first coordinate format, and the system is arranged to convert location data between the first and second coordinate formats.

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28. An asset management system as claimed in claim 27, wherein the first coordinate format conforms to WGS 84 global reference system data.

29. An asset management system as claimed in any one of the preceding claims,
15 wherein the data storage is disposed at a cloud server.

30. An asset management system as claimed in any one of the preceding claims, comprising a LoRaWAN and/or WiFi network at the asset and wherein the operational data obtained from the communication-enabled things is communicated to the data
20 storage using the LoRaWAN and/or the WiFi network.

31. An asset management system as claimed in any one of the preceding claims, comprising an edge server disposed between a wide area network and the communication-enabled things, the edge server arranged to process data obtained
25 from the communication-enabled things and to communicate processed data to the data storage through the wide area network.

32. An asset management system as claimed in any one of the preceding claims, comprising at least one application programming interface (API) arranged to facilitate
30 access to the system and/or the visual data and/or the component data from a remote location.

33. An asset management system as claimed in any one of the preceding claims, comprising an analysis engine arranged to automatically analyse the component data
35 and carry out an action in response to the analysis.

34. An asset management system as claimed in claim 33, wherein the analysis engine is arranged to carry out the analysis using machine learning (ML) and/or artificial intelligence (AI) techniques.
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35. An asset management system as claimed in claim 34, wherein the analysis engine is arranged to instigate a maintenance action in response to the analysis.
36. An asset management system as claimed in claim 34, wherein the analysis engine is arranged to analyse performance of at least one component and to instigate an action when behaviour of the component is determined to deviate from defined normal behaviour.
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37. An asset management system as claimed in claim 34, wherein the analysis engine is arranged to predict a future reduction in performance of at least one component based on current or historical component data.
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38. An asset management system as claimed in any one of the preceding claims, comprising a rules engine arranged to facilitate creation and execution of customised rules to carry out defined actions in response to defined conditions directly or indirectly dependent on the component data.
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39. An asset management system as claimed in any one of the preceding claims, wherein the system is arranged to carry out an action in response to location of an actor at the asset.
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40. An asset management system as claimed in claim 39, wherein the system is arranged to communicate information to the actor in response to location of the actor at the asset.
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41. An asset management system as claimed in claim 39 or claim 40, wherein the system is arranged to communicate operational data to the actor in response to location of the actor at the asset.
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42. An asset management system as claimed in any one of claims 39 to 41,

wherein the system is arranged to update operational data associated with a thing in response to location of the actor at the asset.

43. An asset management system as claimed in claim 42, wherein the system is arranged to communicate warning information to the actor in response location of the actor at the asset.

44. An asset management system as claimed in any one of claims 39 to 43, wherein the system is arranged to carry out an action based on proximity of the actor to a defined component of the asset.

45. An asset management system as claimed in any one of claims 39 to 44, wherein the system is arranged to allocate a task to the actor based on the location of the actor at the asset.

46. An asset management system as claimed in any one of the preceding claims, wherein the actor includes a robot.

47. An asset management system as claimed in claim 46, wherein the system is arranged to cause the robot to carry out a defined action in response to defined criteria.

48. An asset management system as claimed in claim 47, wherein the at least one defined action is instigated by a machine learning (ML) or artificial intelligence (AI) algorithm, an outcome of a defined rule, and/or in response to an instruction from a user.

49. An asset management system as claimed in claim 47 or claim 48, wherein the system is arranged to control the robot to capture visual data indicative of at least one defined portion of the asset.

50. An asset management system as claimed in any one of claims 47 to 49, wherein the system is arranged to control the robot to carry out at least one maintenance action.

51. An asset management system as claimed in any one of claims 1 to 45, wherein the actor comprises a person equipped with a mobile computing device and the system is arranged to communicate a defined action for the person to the mobile computing device in response to defined criteria.
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52. An asset management system as claimed in any one of the preceding claims, comprising a things manager usable to register a communication-enabled thing with the system.
- 10 53. An asset management system as claimed in claim 52, wherein a communication-enabled thing includes a unique machine-readable identifier and the system facilitates capture of the machine-readable identifier in order to identify and register the communication-enabled thing with the system.
- 15 54. An asset management system as claimed in claim 53, wherein the machine-readable identifier comprises a QR code.
55. An asset management system as claimed in any one of claims 52 to 54, wherein the things manager is arranged to facilitate reception of information indicative of:
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- the location of the thing at the asset;
 - the purpose of the thing;
 - how the thing is mounted;
 - an image of the thing when deployed;
 - 25 the component that the thing is associated with;
 - the purpose of one or more sensors of the thing;
 - the part of the component associated with each sensor of the thing; and/or
 - configuration information associated with the thing.
- 30 56. An asset management system as claimed in any one of the preceding claims, comprising a workflow engine arranged to facilitate creation and/or execution of tasks and workflows to be carried out by a user.
57. An asset management system as claimed in claim 56, wherein the workflow
- 35 engine is arranged to define and implement a virtual start of shift sequence of

observations wherein an operator is automatically directed to sequentially inspect a visual representation and component data of a defined set of components and thereby virtually inspect the corresponding actual components of the asset.

- 5 58. An asset management system as claimed in any one of the preceding claims, comprising at least one user application arranged to facilitate access to the visual representations of the asset and the component data derived from the asset, to facilitate virtual operations in relation to the visual representations of the asset and the component data derived from the asset, to facilitate collaboration between users,
10 and/or to facilitate management of tasks and asset personnel.

59. An asset management system as claimed in claim 58, wherein the at least one user application is accessible through a web browser.

- 15 60. An asset management system as claimed in claim 58 or claim 59, wherein the user applications include a process awareness application usable to enable an operator to view a representation of a production process associated with the asset.

- 20 61. An asset management system as claimed in claim 60, wherein the process awareness application is arranged to display a pseudo-3D representation of the production process.

- 25 62. An asset management system as claimed in claim 60 or claim 61, wherein the representation of the production process is shareable virtually so that multiple users may collaborate to view, design, modify and/or troubleshoot the process.

- 30 63. An asset management system as claimed in any one of claims 60 to 62, wherein the process awareness application is arranged to facilitate addition of at least one data point to the representation of the production process, each data point associated with user selected operational data.

64. An asset management system as claimed in any one of claims 1 to 59, wherein the system is arranged to facilitate addition of at least one data point to the visual representation, each data point associated with user selected operational data.

65. An asset management system as claimed in any one of claims 58 to 64, wherein the user applications include a chat application that enables an operator to interact with other operators of the system.

- 5 66. An asset management system as claimed in claim 65, wherein the chat application facilitates linking of a chat to a specific location of the asset or a specific asset component.

67. An asset management system as claimed in any one of claims 58 to 66,
10 wherein the user applications also include a voice application that provides an operator with the ability to interact with the system using voice commands and voice responses.

68. An asset management system as claimed in any one of the preceding claims, wherein the asset is a resources industry asset.

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69. A method of managing an asset, the method comprising:

storing visual data indicative of a visual representation of an asset at a data storage, the visual representation including visual representations of components of the asset;

- 20 storing component data indicative of characteristics of components of the asset including operational data indicative of operation of the components at the data storage;

- storing spatial data including component location data indicative of location of the components relative to the asset in a first coordinate format according to a defined
25 coordinate system, and actor location data indicative of location of at least one actor disposed at the asset as the actor moves relative to the asset;

- disposing a plurality of communication-enabled things disposed at the asset, each communication-enabled thing arranged to obtain operational data indicative of operation of at least one component of the asset and to communicate the operational
30 data to the data storage;

facilitating access to the stored visual data using a user interface, the user interface controllable by a user to display a visual representation of a selected portion of an asset, and to display visual representations of adjacent portions of the asset by receiving navigation instructions from the user;

- 35 facilitating display on the user interface of component information adjacent a

component as the user navigates through the visual representation of the asset, the component information derived from the communication-enabled thing associated with the component;

obtaining actor location data; and

5 storing the actor location data in the first coordinate format.

70. A method as claimed in claim 69, comprising automatically displaying component information adjacent a component as the user navigates through the visual representation of the asset when the visual representation of the component is
10 displayed by the user interface.

71. A method as claimed in claim 70, comprising displaying further component information in response to user input.

15 72. A method as claimed in claim 69, comprising displaying component information adjacent a component in response to user input when the visual representation of the component is displayed by the user interface.

20 73. A method as claimed in claim 69, wherein at least some of the component information displayed adjacent a component is based on user defined criteria.

74. A method as claimed in any one of claims 69 to 73, wherein the component data includes data indicative of the type of component.

25 75. A method as claimed in any one of claims 69 to 74, wherein the component data includes timing data associated with component operational data, the timing data indicative of the time at which operational data is obtained from a component.

30 76. A method as claimed in claim 75, wherein the displayed component information includes the timing data.

77. A method as claimed in any one of claims 69 to 76, wherein the displayed component information includes maintenance information.

35 78. A method as claimed in any one of claims 69 to 77, comprising displaying a

time dependent visual representation of a portion of the asset and time dependent component information adjacent a component of the portion of the asset in response to selection of a time by a user.

5 79. A method as claimed in any one of claims 69 to 78, wherein the visual representation of the asset includes a visual representation of an actor at a location corresponding to the location of the actor at the asset.

80. A method as claimed in any one of claims 69 to 79, wherein the component
10 location data includes timing data indicative of the time at which a component is disposed at a location.

81. A method as claimed in any one of claims 69 to 80, wherein the actor location
15 data includes timing data indicative of the time at which an actor is disposed at a location.

82. A method as claimed in any one of claims 69 to 81, wherein the actor
comprises a geolocation device arranged to produce the actor location data indicative
of the location of the actor relative to the asset.

20 83. A method as claimed in claim 82, wherein the actor comprises a mobile computing device, the mobile computing device including the geolocation device.

84. A method as claimed in any one of claims 69 to 81, wherein the actor includes
25 a location device and the method comprises providing a plurality of machine-readable markers disposed at distributed locations at the asset, and determining the location of the location device relative to the machine-readable markers and thereby the location of the actor relative to the asset.

30 85. An asset as claimed in claim 84, wherein the machine-readable markers include visual location markers or Bluetooth beacons.

86. An asset as claimed in claim 82, comprising determining the location of the
actor relative to the asset using simultaneous localisation and mapping (SLAM)
35 techniques.

87. A method as claimed in any one of claims 69 to 86, wherein the component data includes:

- 5 data indicative of audio;
- data indicative of video;
- data indicative of at least one image;
- data indicative of vibration;
- data indicative of temperature;
- data indicative of electrical current;
- 10 data indicative of flow rate;
- data indicative of pressure;
- data indicative of speed of movement;
- data indicative of control values;
- data indicative of equipment performance;
- 15 data indicative of position or state of a part of a component; and/or
- data indicative of operational status (ON/OFF) of a component.

88. A method as claimed in any one of claims 69 to 87, wherein the plurality of communication-enabled things includes any one or more of:

- 20 a microphone;
- a sensor;
- a programmable logic controller (PLC) device.

89. A method as claimed in any one of claims 69 to 88, wherein the plurality of communication-enabled things includes a still and/or video camera.

90. A method as claimed in claim 89, wherein the spatial data includes data indicative of the location shown in the field of view of the camera.

30 91. A method as claimed in any one of claims 69 to 90, comprising automatically playing audio associated with a portion of the asset as the user navigates through the visual representation of the asset and the portion of the asset is displayed, the audio derived from at least one microphone.

35 92. A method as claimed in any one of claims 69 to 91, wherein each thing is

incorporated into a component, connected to a component or disposed adjacent the component.

93. A method as claimed in any one of claims 69 to 92, wherein the visual data
5 indicative of a visual representation of an asset comprises image data indicative of images of the asset, virtual representations indicative of the asset, and/or point cloud data indicative of the asset.

94. A method as claimed in claim 93, wherein the virtual representations comprise
10 CAD representations.

95. A method as claimed in any one of claims 69 to 92, wherein the user interface
uses a second coordinate format different to the first coordinate format, and the
method comprises converting location data between the first and second coordinate
15 formats.

96. A method as claimed in claim 95, wherein the first coordinate format conforms
to WGS 84 global reference system data.

97. A method as claimed in any one of claims 69 to 96, comprising disposing the
20 data storage at a cloud server.

98. A method as claimed in any one of claims 69 to 97, comprising a LoRaWAN
and/or WiFi network at the asset, the method comprising obtaining the operational data
25 from the communication-enabled things and communicating the operational data to the data storage using the LoRaWAN and/or the WiFi network.

99. A method as claimed in any one of claims 69 to 98, comprising processing data
obtained from the communication-enabled things using an edge server disposed
30 between a wide area network and the communication-enabled things, and communicating processed data to the data storage through the wide area network.

100. A method as claimed in any one of claims 69 to 99, comprising facilitating
access to the system and/or the visual data and/or the component data from a remote
35 location using at least one application programming interface (API).

101. A method as claimed in any one of claims 69 to 100, comprising automatically analysing the component data using an analysis engine and carrying out an action in response to the analysis.
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102. A method as claimed in claim 101, comprising carrying out the analysis using machine learning (ML) and/or artificial intelligence (AI) techniques.
103. A method as claimed in claim 102, comprising instigating a maintenance action in response to the analysis.
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104. A method as claimed in claim 102, comprising analysing performance of at least one component and instigating an action when behaviour of the component is determined to deviate from defined normal behaviour.
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105. A method as claimed in claim 102, comprising predicting a future reduction in performance of at least one component based on current or historical component data.
106. A method as claimed in any one of claims 69 to 105, comprising facilitating creation and execution of customised rules to carry out defined actions in response to defined conditions directly or indirectly dependent on the component data.
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107. A method as claimed in any one of claims 69 to 106, comprising carrying out an action in response to location of an actor at the asset.
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108. A method as claimed in claim 107, comprising communicating information to the actor in response to location of the actor at the asset.
109. A method as claimed in claim 107 or claim 108, comprising communicating operational data to the actor in response location of the actor at the asset.
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110. A method as claimed in any one of claims 107 to 109, comprising updating operational data associated with a thing in response to location of the actor at the asset.
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111. A method as claimed in any one of claims 107 to 110, comprising communicating warning information to the actor in response location of the actor at the asset.
- 5 112. A method as claimed in any one of claims 107 to 111, comprising carrying out an action based on proximity of the actor to a defined component of the asset.
113. A method as claimed in any one of claims 107 to 112, comprising allocating a task to the actor based on the location of the actor at the asset.
- 10 114. A method as claimed in any one of claims 69 to 113, wherein the actor includes a robot.
115. A method as claimed in claim 114, comprising causing the robot to carry out a
15 defined action in response to defined criteria.
116. A method as claimed in claim 115, comprising instigating at least one defined action by a machine learning (ML) or artificial intelligence (AI) algorithm, an outcome of a defined rule, and/or in response to an instruction from a user.
- 20 117. A method as claimed in claim 115 or claim 116, comprising controlling the robot to capture visual data indicative of at least one defined portion of the asset.
118. A method as claimed in any one of claims 115 to 117, comprising controlling
25 the robot to carry out at least one maintenance action.
119. A method as claimed in any one of claims 69 to 113, wherein the actor comprises a person equipped with a mobile computing device and the system is arranged to communicate a defined action for the person to the mobile computing
30 device in response to defined criteria.
120. A method as claimed in any one of claims 69 to 119, comprising using a things manager to register a communication-enabled thing with the system.
- 35 121. A method as claimed in claim 120, wherein a communication-enabled thing

includes a unique machine-readable identifier and the method comprises capturing the machine-readable identifier in order to identify and register the communication-enabled thing with the system.

- 5 122. A method as claimed in claim 121, wherein the machine-readable identifier comprises a QR code.

123. A method as claimed in any one of claims 120 to 122, wherein the things manager is arranged to facilitate reception of information indicative of:

- 10 the location of the thing at the asset;
 the purpose of the thing;
 how the thing is mounted;
 an image of the thing when deployed;
 the component that the thing is associated with;
15 the purpose of one or more sensors of the thing;
 the part of the component associated with each sensor of the thing; and/or
 configuration information associated with the thing.

- 20 124. A method as claimed in any one of claims 69 to 123, comprising facilitating creation and/or execution of tasks and workflows to be carried out by a user.

- 25 125. A method as claimed in claim 124, comprising facilitating definition and implementation of a virtual start of shift sequence of observations wherein an operator is automatically directed to sequentially inspect a visual representation and component data of a defined set of components and thereby virtually inspect the corresponding actual components of the asset.

- 30 126. A method as claimed in any one of claims 69 to 125, comprising enabling an operator to view a representation of a production process associated with the asset.

127. A method as claimed in claim 126, comprising displaying a pseudo-3D representation of the production process.

- 35 128. A method as claimed in claim 126 or claim 127, comprising facilitating virtual sharing of the production process so that multiple users may collaborate to view,

design, modify and/or troubleshoot the process.

129. A method as claimed in any one of claims 126 to 128, comprising facilitating addition of at least one data point to the representation of the production process, each
5 data point associated with user selected operational data.

130. A method as claimed in any one of claims 69 to 125, comprising facilitating addition of at least one data point to the visual representation, each data point associated with user selected operational data.

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131. A method as claimed in any one of claims 126 to 130, wherein the user applications include a chat application that enables an operator to interact with other operators of the system.

- 15 132. A method as claimed in claim 131, comprising facilitating linking of a chat to a specific location of the asset or a specific asset component.

133. A method as claimed in any one of claims 126 to 132, comprising providing an operator with the ability to interact with the system using voice commands and voice
20 responses.