PACK2 THE TERMINATOR BUILDTHE 800

THE MOST LEGENDARY CYBORG IN SCIENCE FICTION HISTORY!



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1:2 SCALE

CRANNATOR BUILD THE T-800 PACK 2

CONTENTS

T-800 ASSEMBLY: STAGES 11-20

STAGE 11: ASSEMBLING NECK AND JAW JOINTS
STAGE 12: ASSEMBLING THE RIGHT FOREARM
STAGE 13: ASSEMBLING THE NECK AND A RIGHT FINGER COMPONENT
STAGE 14: ADDING TO THE RIGHT LOWER ARM, AND ASSEMBLING THE FOURTH RIGHT FINGER
STAGE 15: ASSEMBLING PART OF THE LEFT HEAD AND THE FIFTH FINGER OF THE RIGHT HAND
STAGE 16: BEGIN THE ASSEMBLY OF THE FIRST LOWER ARM
STAGE 17: FITTING THE SIDES OF THE HEAD TO THE TOP OF THE HEAD
STAGE 18: ASSEMBLING THE EYE MOTOR SUPPORT
STAGE 19: ASSEMBLE THE HEAD MOTOR
STAGE 20: ASSEMBLE AND MOUNT THE HEAD MOTOR SUPPORT
CI FI CINEMA: CYBORGS AND ROBOTS

IDENTIFYING YOUR COMPONENTS: Each of your Terminator packs is divided into stages. Each stage contains a number of components, and can be identified by referring to the images in your assembly guide or the number located on the sticker on the back of each stage. Each number begins with '77' and is followed by a further three digits. The last three digits indicate the number of each stage. For example, 77 001 indicates stage 01, 77 002 indicates stage 02, etc.

Find more helpful building tips and advice at community.agoramodels.com

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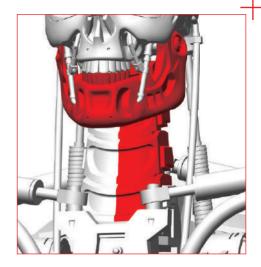
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The editor's policy is to use papers that are natural, renewable and recyclable products and made from wood grown in sustainable forests. The logging and manufacturing processes are expected to conform to the environmental regulations of the country of origin.

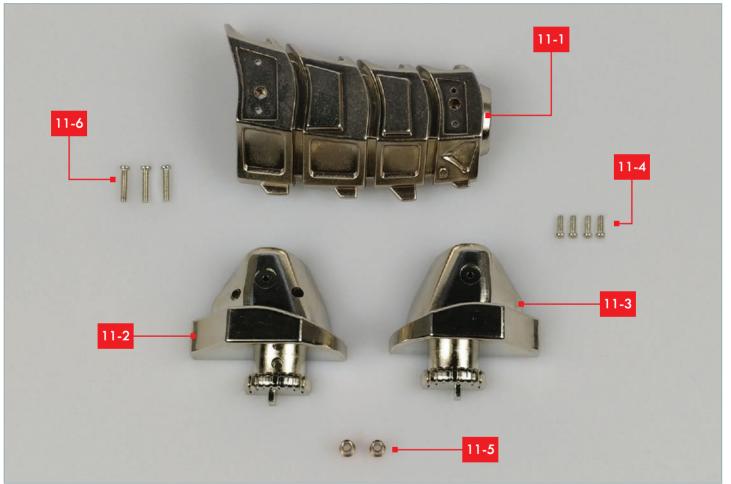
Not suitable for children under the age of 14. This product is not a toy and is not designed for use in play. Keep the parts out of the reach of small children. Some parts may have sharp edges. Please handle them with care.

3

STAGE 11: ASSEMBLING NECK AND JAW JOINTS



In this stage you will construct a neck joint and assemble the lower jaw joint.



LIST OF PIECES

- 11-1 Neck 11-2 Neck Joint - R
- 11-3 Neck Joint L

- **11-4** 4 x PB 2x6mm screws (1 spare)
- 11-5 2x brass bushes
- 11-6 3x PM 2x10mm screws (1 spare)

YOU WILL ALSO NEED

Part 5-1, lower jaw Part 6-1, lower jaw Part 7-5, head motor joint

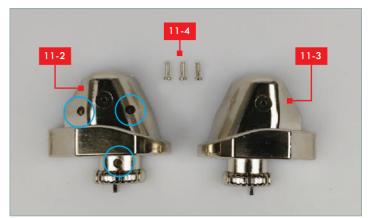
A suitable cross-head screwdriver

4



STEP 1

Firstly, find the neck section (**11-1**) and put it to one side. You'll next need it to assemble the neck in stage 13, so store it in a safe place for now.



STEP 2

Take neck joint parts **11-2** and **11-3** along with three PB 2x6mm screws (**11-4**).



STEP 3

The inside of the parts have raised screw sockets and matching recesses to locate the parts when joined together, as shown.



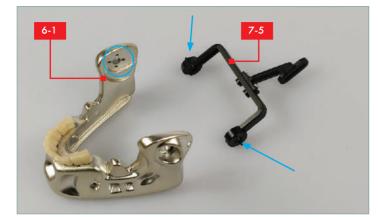
STEP 4

Secure the two parts together using the three 2x6mm screws (11-4) as shown in the three photographs above.



STEP 5 When completed, put the neck joint safely aside until it is needed in a later stage.

5



STEP 6

Now, take the lower jaw (6-1) from stage 06 and the head motor joint (7-5) from stage 07 and note the locating pins (marked with blue arrows) on part 7-5. Note also, the matching holes (circled in blue) in the jaw part (6-1).



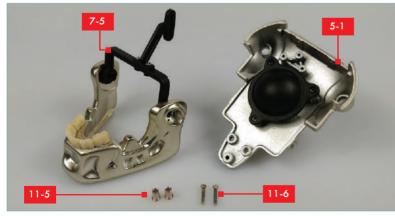
STEP 7

Attach **7-5** inside **6-1** as shown. **7-5** snaps into the locating holes on either side of the lower jaw.



STEP 8

Now take the lower jaw parts 5-1 which was assembled in stage 05 and note the screw holes on either side, circled above in blue.



STEP 9

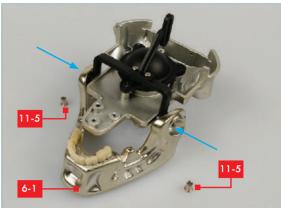
In the next steps the two jaw parts are connected as shown above, right. You will also need the two brass bushes (**11-5**) and two PM 2x10mm screws (**11-6**).





STEP 10

There are grooves on either inner side of part **7-5** (see above left) into which the screw sockets on part **5-1** slide. Part **5-1** is fitted from below as shown above, right.



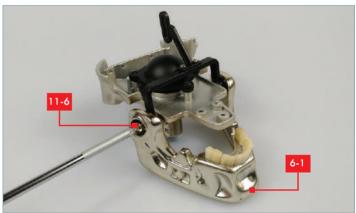
STEP 11

Once the two parts are together, take the two brass brass bushes **11-5** and insert them in the holes each side of jaw part **6-1**, as indicated by the blue arrows.



STEP 12

Insert a 2×10 mm screw (**11-6**) into the previously fitted brass bush and tighten fully to secure the left side of the joint.



STEP 13

Repeat the previous step, this time securing the joint from the right side with the second 2x10mm screw (**11-6**).



STEP 14 Your completed lower jaw section will look like this.



STAGE COMPLETE

This is how your three components should look at the end of this stage. Store them safely — you'll be needing all three for stage 13.

6

7

STAGE 12: ASSEMBLING THE RIGHT FOREARM

In this stage, you'll apply a metallic muscle to the right forearm.



LIST OF PIECES

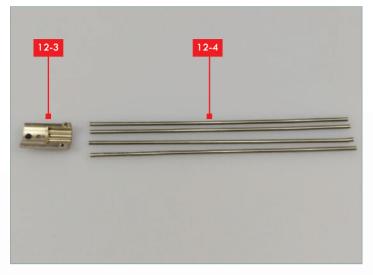
- 12-1 Forearm A
- 12-2 Forearm B
- 12-3 Forearm C
- 12-4 4 x Forearm Muscle Springs
- 12-5 2x KB 2x4mm screws (1 spare)
- 12-6 2x PM 3x12mm screws (1 spare)

YOU WILL ALSO NEED

An appropriate cross-head screwdriver.

Superglue gel, and a cocktail stick or similar with which to apply it.

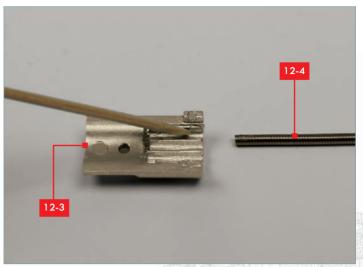
8



STEP 1

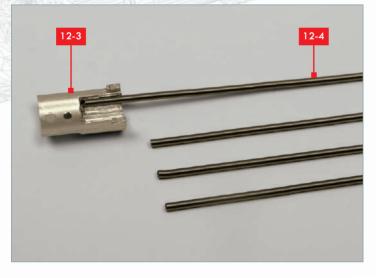
Take forearm C (12-3) and the four forearm muscle springs (12-4).

You'll be glueing all four of the springs into the four grooves in part **12-3**. The use of tweezers may be helpful in the following steps.



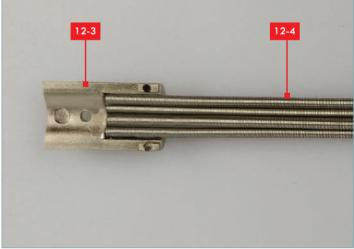
STEP 2

Using a cocktail stick or similar, apply a small amount of superglue to one of the four grooves in **12-3**.



STEP 3

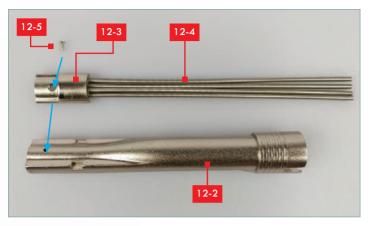
After applying the glue, place one of the springs 12-4 in the groove and hold it firmly in place with a cocktail stick or similar until the spring is securely held in place.



STEP 4

Repeat the previous step to secure all four springs in place, as shown above.

9



STEP 5

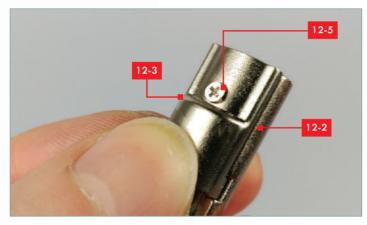
Now take forearm B (12-2) and one of the KB 2x4mm screws (12-5).

Attach **12-3** to **12-2**, using the screw to hold it in place, as marked by the blue connecting arrows in the photo.



STEP 6

Fit **12-3** into the grooves at the top of **12-2**, taking note of the screw hole circled in blue.



STEP 7

Insert the screw 12-5 and tighten fully to connect the two forearm elements.



STEP 8

The forearm will look like this once screwed together.

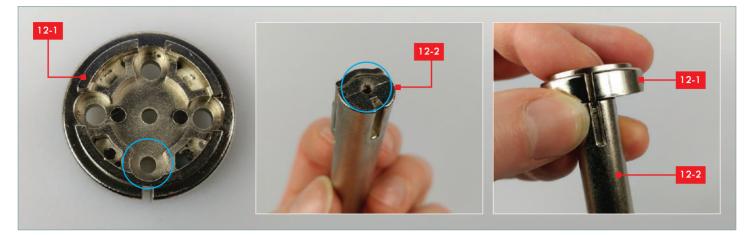


STEP 9

Now, take forearm A **(12-1)** and align it with the rest of the forearm as shown above. Note the hole indicated by the blue arrow in part 12-1 which receives a PM 3x12mm screw **(12-6)**.

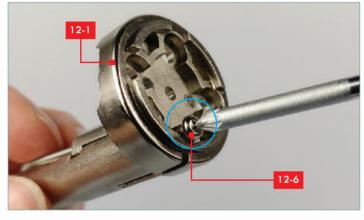
Note the grooves on the bottom of both **12-1** and **12-2** — their alignment ensures that the correct screw hole is used for this connection.





STEP 10

Again, taking note of the position of the screw holes and grooves in part **12-1** and **12-2**, place the parts together.

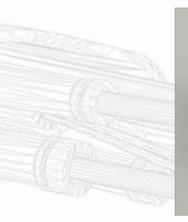


STEP 11

Tighten the screw (**12-6**) through the screw hole circled on part **12-1** and securely join the two parts together.



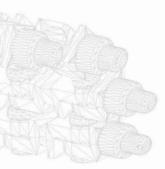
STEP 12 The screw should sit below the rim of the area around it, as shown.





STAGE COMPLETE

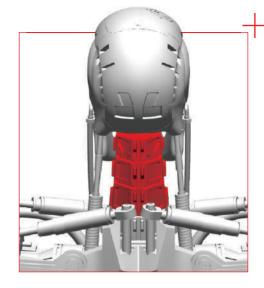
This is how your completed forearm should look. Store it safely away, as you'll need to connect it to the rest of the arm in a future stage.

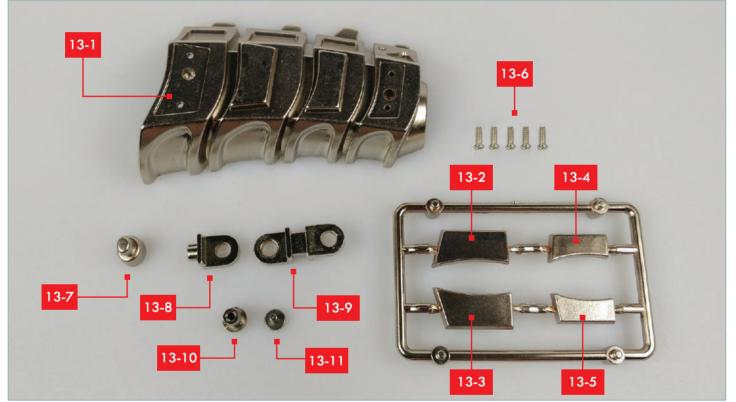


11

STAGE 13: ASSEMBLING THE NECK AND A RIGHT FINGER COMPONENT

In this stage, you'll assemble the neck and connect it to the lower jaw, and start the assembly of another right finger.





LIST OF PIECES

13-1	Neck Right
13-2	Large Neck Plate L
13-3	Large Neck Plate R
13-4	Small Neck Plate L
13-5	Small Neck Plate R
13-6	5x PB 2x6mm screws (1 spare)

13-7	Right Fourth Finger A
13-8	Right Fourth Finger B
13-9	Right Fourth Finger C
13-10	Finger Connector A
13-11	Finger Connector B

YOU WILL ALSO NEED

An appropriate cross-head screwdriver

Superglue gel and a cocktail stick or similar with which to apply it

6-1 - Lower Jaw Assembly from stage 11

11-1 – Neck Left, from stage 11

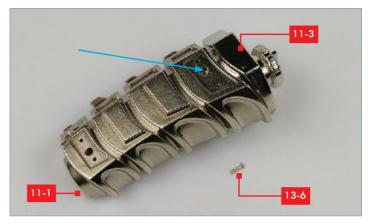
11-2/11-3 – Neck Joint, from stage 11

12



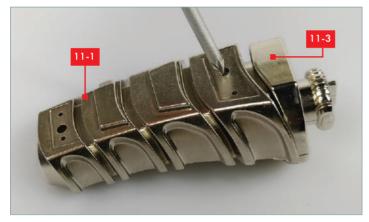
STEP 1

Place the neck part **11-1** and assembly **11-2/11-3** constructed in stage 11 on the work surface, as shown. Note the screw sockets circled in yellow on the underside (see inset).



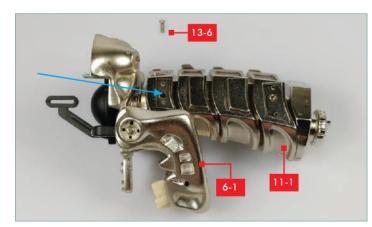
STEP 2

With the parts as shown above, slide part **11-3** under neck part **11-1**. Notice how the previously mentioned holes align and engage (marked with a blue arrow above). You will need a PB 2 x 6mm (**13-6**) screw for the next step.



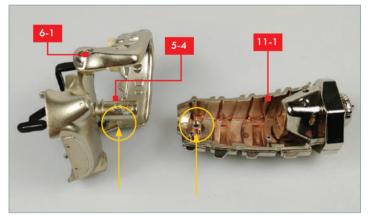
STEP 3

Insert the PB screw in the hole and fully tighten to secure the parts together.



STEP 5

Turn the parts over, as shown above, and slide the jaw assembly (**6-1**) under neck part **11-1**. As before, notice how the previously mentioned screw sockets align and engage (also marked with a blue arrow above). You will need a PB 2 x 6mm (**13-6**) screw for the next step.



STEP 4

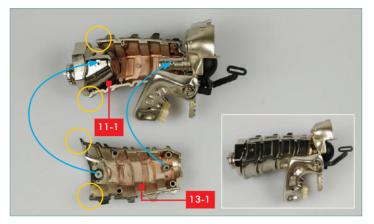
Next take the jaw assembly **6-1** which was last worked on in stage 11 and note the raised screw sockets, circled in yellow, on part **5-4** and on the underside of part **11-1**.



STEP 6

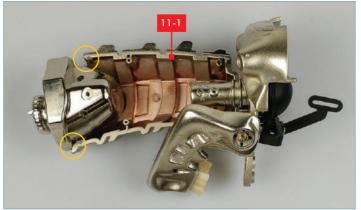
Insert the PB screw in the hole and fully tighten to secure the parts together.

13



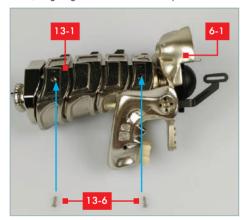
STEP 7

Turn the assembly over and take neck part **13-1**; note the small holes, circled in yellow. These holes receive small pins, also circled in yellow, on part **11-1**. Test-fit part **13-1** on top of part **11-1** as shown in the inset, aligning the holes marked by blue arrows.



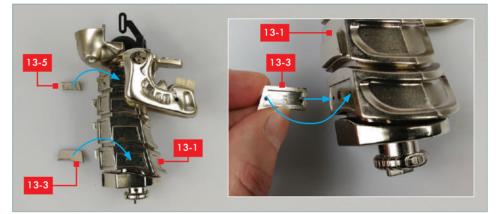
STEP 8

Separate the parts again and apply a small drop of superglue to each of the small pins on part **11-1** (circled in yellow).



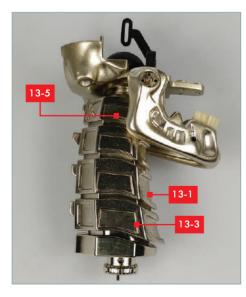
STEP 9

Re-fit part **13-1** on top of part **11-1**. Secure the two parts together by inserting two **13-6** screws, as shown by the blue arrows, and fully tighten.



STEP 10

Carefully remove neck plates **13-2**, **13-3**, **13-4**, and **13-5** from their framework and smooth any rough edges with fine sandpaper. Take the right neck plates **13-3** and **13-5** which push-fit into the right side of the neck (**13-1**). Each of the plates has two small pegs which connect with the corresponding holes in **13-1**, as shown in the inset.

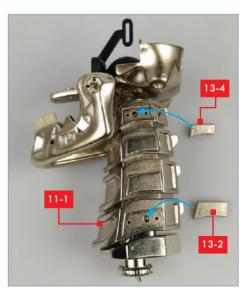


STEP 11

The plates look like this when fixed in position.



Repeat the step for the other side of the neck (11-1), pushfitting 13-2 and 13-4 into place as shown.

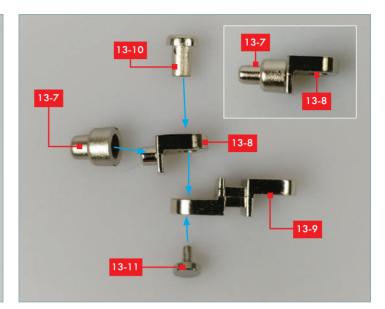


14



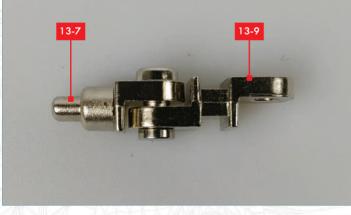
STEP 13

The plates look like this when fixed in position.



STEP 14

Move now to the finger components. In a similar way to the other fingers and thumb you have previously built, connect **13-7** to **13-8**, as shown in the insert. You may it helpful to apply a small drop of superglue to hold part **13-7** firmly in place. Then connect **13-8** to **13-9** using the two connectors, **13-10** and **13-11**, following the lines of assembly indicated in the main photo.



STEP 15

Your completed finger component will look like this.



STAGE COMPLETE!

This is how your completed finger joint and the combined neck section should look. Store both pieces safely away — you'll need the finger joint in the next stage.

STAGE 14: ADDING TO THE RIGHT LOWER ARM, AND ASSEMBLING THE FOURTH RIGHT FINGER

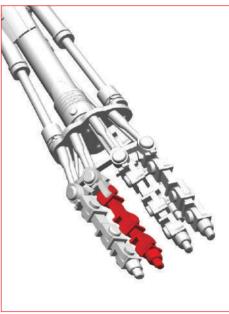
In this stage, you'll add three more metallic muscles to the lower arm that you began to assemble in stage 12, and finish the right finger that you started in the last stage.



LIST OF PIECES

14-1	Lower Arm Tube A	14-6	Right Fourth Finger E
14-2	2 x Lower Arm Tube B	14-7	3 x Finger Connectors A
14-3	3 x Bushes	14-8	2 x Finger Connectors B
14-4	4×2×16mm screws (1 spare)	14-9	Knuckle Connector
14-5	Right Fourth Finger D		





YOU WILL ALSO NEED

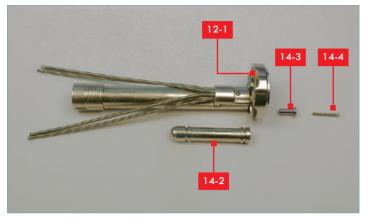
An appropriate cross-head screwdriver

13-8/13-9 – Right Fourth Finger, assembled in stage 13

12-1/12-2 – Lower Arm, assembled in stage 12

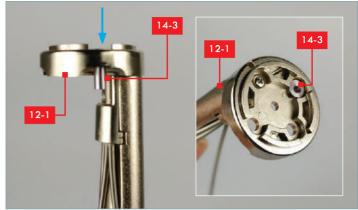
8-1 – Right Hand, last used in stage 10.

15



STEP 1

First, take the lower arm assembly **12-1** from stage 12 along with a lower arm tube B **14-2**, a bush **14-3** and a 2 x 16mm screw **14-4**.



STEP 2

Insert the first bush 14-3 into 12-1, using the inset photo as a guide.

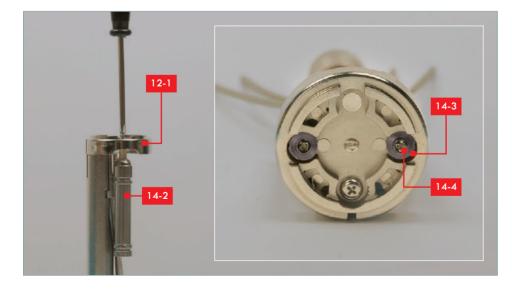


STEP 3 Next, fit in place a lower arm tube 14-2 onto 14-3, as shown.



STEP 4

Insert a 2×16 mm screw **14-4** into bush **14-3** and tighten fully to secure the arm tube **14-2** in place. Note how the bush is still visible when the screw is fully tightened (circled in blue).



STEP 5

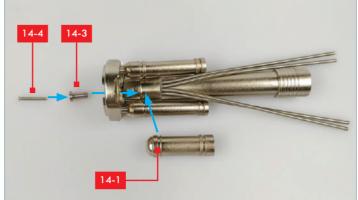
Repeat step 4 on the other side of arm part **12-1**. As before, after inserting the bush **14-3**, secure the second lower arm tube **14-2** in place using a 2 x 16mm screw.

17



STEP 6

With the parts fitted so far, your lower arm now looks like this.



STEP 7

Now, take the lower arm tube A 14-1 , a bush 14-3 and a $2\,\times$ 16mm screw 14-4.



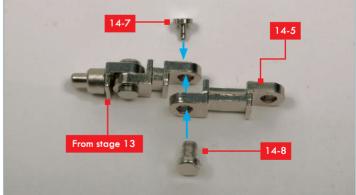
STEP 8

In a similar way to the previous steps, insert a bush **14-3** into the remaining hole in part **12-1** (inset circled in blue) and fit the arm tube **14-1** as shown above. Secure in place with a 2 x 16mm screw **14-4**.



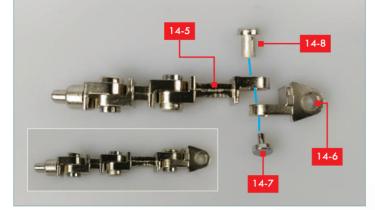


STEP 9 The lower arm section looks like this when completed.



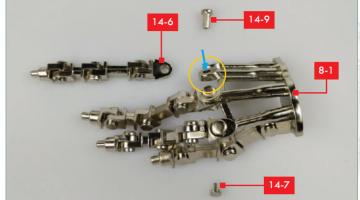
STEP 10

Along with the finger components constructed in stage 13, lay part **14-5**, as well as connectors **14-7** and **14-8**, on the work surface. As before, push the connectors together, as shown by the blue arrows, to join the parts.



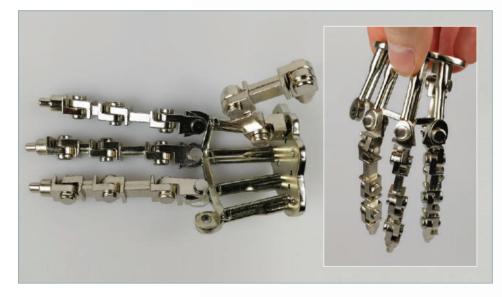
STEP 11

In the usual way, join part 14-6 to the finger assembly using connector parts **14-7** and **14-8**. The inset shows how the completed finger should look.



STEP 12

Finally, connect the finger to the knuckle assembly **8-1**. As before, part **14-6** fits under the knuckle **8-1** and is secured in place with connector **14-7** below and connector **14-9** above.





STEP 13

This is how the hand should now look after connecting the fourth finger.

STAGE COMPLETE!

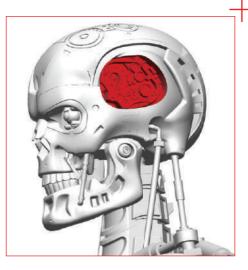
This is how your newly-added finger and right hand should look, alongside the assembled lower arm.

Check the pieces against the photos throughout this section, then store them carefully away.

19

STAGE 15: ASSEMBLING PART OF THE LEFT HEAD AND THE FIFTH FINGER OF THE RIGHT HAND

Two parts of the left head are assembled, and we put together the last finger of the right hand and attach it to the rest of the hand.

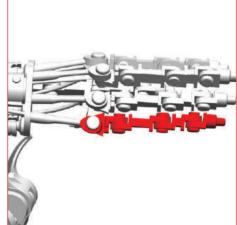




LIST OF PIECES

15-1	Left head A
15-2	Left head B (inner)
15-3	Fifth finger A
15-4	Fifth finger component B
15-5	Fifth finger component C
15-6	Fifth finger component D
15-7	Fifth finger component E

15-8	3 x fifth finger connectors (bolts)
15-9	Fifth finger knuckle connector (bolt)
15-10	4 x fifth finger connectors (pins)
15-11	3 x PM 2 x 4mm screws (1 spare)
15-12	3 x fifth finger connectors (sheaths)
15-13	Fifth finger knuckle connector (sheath)



YOU WILL ALSO NEED

An appropriate cross-head screwdriver.

Tweezers

Superglue and a cocktail stick or toothpick with which to apply it.

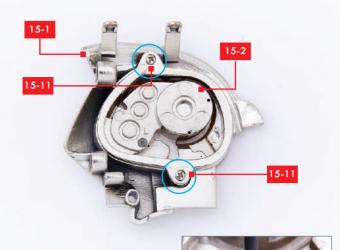
EXPERT TIP!

Reverse tweezers are easier to use than normal tweezers. When you squeeze the grips, the jaws open, and as you release the grips the jaws hold the part without having to apply pressure to the tweezer grips.



STEP 1

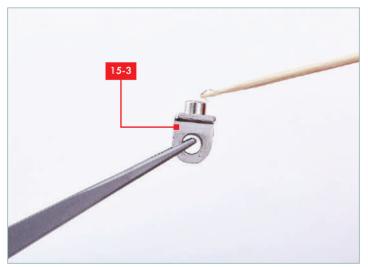
Take the two parts of the left head, **15-1** and **15-2**. Fit the inner part **15-2** into the opening in part **15-1**, as shown.



STEP 2

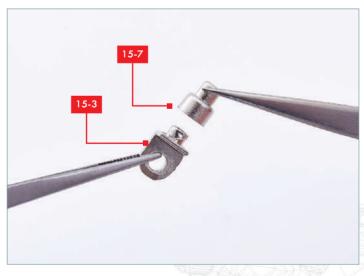
Turn the parts over and fix the two head parts together with two PM screws **15-11** (circled). Note that the screws are fixed from inside the inner section of the left head **15-2**.





STEP 3

Take the first two parts of the finger: fifth finger E (the tip of the finger) **15-7** and fifth finger A **15-3**. Apply a little superglue to the peg on part **15-3**.



STEP 4 Fit tip of the finger 15-7 on to part 15-3.

21



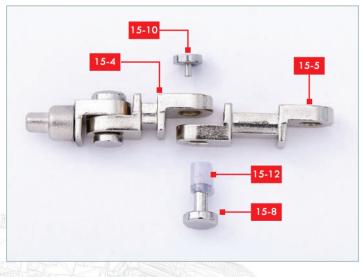
STEP 5

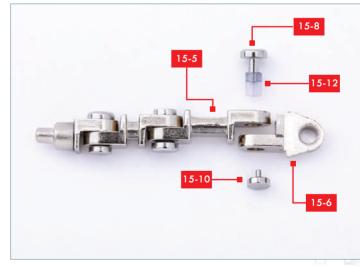
Take the next part of the fifth finger B **15-4**. You will also need one connection sheath **15-12** which passes through the join, a small connector bolt **15-8** and a connection pin **15-10**. Fit the sheath onto the bolt and then fit the bolt and sheath through the holes in parts **15-3** and **15-4**.



STEP 6

Apply a little glue to the end of pin **15-10**. Fix it into the hole in bolt **15-8**. Squeeze the bolt and pin firmly together so that they grip parts **15-3** and **15-4** together.





STEP 7

Take finger part **15-5**, which fits onto part **15-4**. You will also need a set of connectors **15-8**, **15-12** and **15-10**. This time, the bolt and sheath should be inserted from the opposite side. When in place, complete the join by applying a little glue to the end of the pin on part **15-10** and fix it into the socket on part **15-8**. Squeeze the bolt and pin firmly together so that they grip parts **15-4** and **15-5** together.

STEP 8

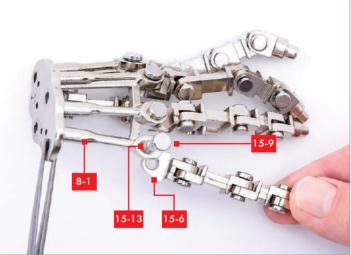
Take the next component **15-6** and a set of connectors **15-8**, **15-12** and **15-10**. Align the holes on parts **15-6** and **15-5** and fix together as before, this time inserting the bolt from the top.





STEP 9

The finished finger, with three joints that are moveable but firm, so that you can arrange them at different angles.



STEP 10

Take the hand assembly from stage 14 and identify the fixing point for the fifth finger on the palm of the hand **8-1**. Align the holes in parts **15-6** and part **8-1**. Fit the sheath **15-13** over bolt **15-9** and fit it through the holes. Apply a little glue to the end of the pin on the fourth part **15-10** and fix it into the socket of part **15-9**. Grip the pin and the bolt firmly together until the glue has dried.



STAGE COMPLETE!

Two parts of the head have been fitted together and the fifth finger has been assembled and connected to the rest of the right hand.

23

STAGE 16: BEGIN THE ASSEMBLY OF THE FIRST LOWER ARM

In this stage, you'll put together the first section of the right forearm, and begin to connect up more components.



LIST OF PIECES

- 16-1 Lower arm A
- **16-2** Lower arm notched ring
- 16-3 3 x lower arm B
- 16-4 3 x lower arm rubber washers

16-5	2 × PM 3 × 12mm screws (1 spare)

- **16-6** 4 x PB 2 x 6mm screws (1 spare)
- 16-7 2 x M3 metal spring washer (1 spare)

YOU WILL ALSO NEED

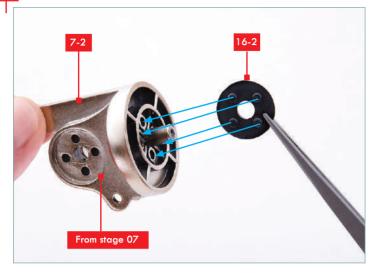
The upper arm joint assembled in stage 07.

The right forearm assembly (with muscles) from stage 12.

A suitable cross-head screwdriver



24



STEP 1

Fit the notched arm ring **16-2** on to the base of the arm joint from stage 07 (part **7-2**). Note that there are four pegs on part **16-2** that fit into sockets on the base of the joint, as indicated by the arrows.



STEP 2

When correctly fitted, the notched ring **16-2** fits snugly into the recess in part **7-2**.



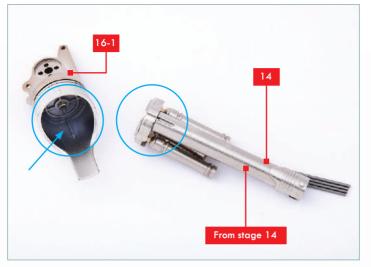
STEP 3 Fit lower arm A **16-1** on to the peg at the centre of the arm joint.



STEP 4

Ensure that the markings on part **16-1** are correctly aligned with part **7-2**, as shown.

25



STEP 5

You will now need the arm and muscle assembly from stage 14. Note that there is a recess in the parts from stage 14 and a raised tab on the inside of part **16-1** (circled).



STEP 6

Fit the lower arm assembly into part **16-1**. Have a PM 3 x 12mm screw (**16-5**) and M3 spring washer (**16-7**) ready.



STEP 7

Fit the washer **16-7** over the screw **16-5**. Use the screw to fix together the elements that you have assembled, inserting it through the centre of part **12-1** and into the screw socket on part **7-2**.





STEP 8

Take a lower arm B **16-3**, a rubber washer **16-4** and a screw PB 2×6 mm (**16-6**). Fit the washer over the screw and then fix the screw into the narrow end of part **16-3**.

STEP 9

Tighten the screw fully but do not over-tighten; the washers should still be able to rotate on the screw. Repeat step 05 to assemble the two additional lower arm B sections. Fit them into the three lower arm tubes as shown in the photo below.



STAGE COMPLETE

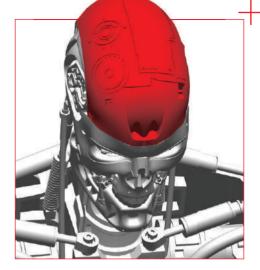
The first lower arm is beginning to take shape.

26

27

STAGE 17: FITTING THE SIDES OF THE HEAD TO THE TOP OF THE HEAD

In this stage, you will attach the sides of the head assembled in stages 09 and 15 to the top of the head, supplied with this stage. You'll also add ball joints to the base of the hand.







LIST OF PIECES

17-1 Top of head

- 17-2 3 x ball joints for right wrist
- **17-3** 5 × PM 2 × 4mm screws (1 spare)
- **17-4** 4 × KB 2 × 6mm screws (1 spare)

YOU WILL ALSO NEED

Right side head assembly from stage 09 and left side head assembly from stage 15.

The hand assembly from stage 15.

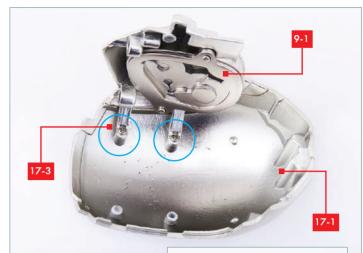
A cross-head screwdriver.





STEP 1

Take the right side head assembly from stage 09 and check how it fits into the top of the head $17\mathchar`-1$.



STEP 2

Fix the right side of the head to the right side of the top of the head **17-1** using two PM 2 x 4mm screws (circled).





STEP 3

Fit the left side of the head assembled in stage 15 to the left side of the top of the head **17-1** and fix in place using two PM 2 x 4mm screws.



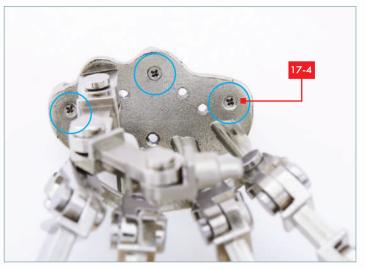
STEP 4

Take the three ball joints **17-2** and identify the fixing points on the base of the palm of the hand (circled in blue).



STEP 5

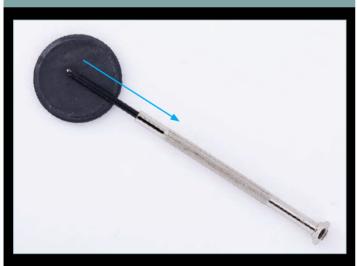
Fit the three ball joints 17-2 into the recesses in the palm of the hand.



STEP 6

Fix each of the three ball joints in place using a KB 2 x 6mm screw (circled). You may find it helpful to carefully hold the ball joints in place with pliers whilst fitting the screws.

EXPERT TIP!



It is easier to position the screws if you have a magnetic screwdriver to pick up the screws. If your screwdriver is not magnetic, draw it across a magnet in one direction, as indicated by the arrow, to induce magnetism.



STAGE COMPLETE

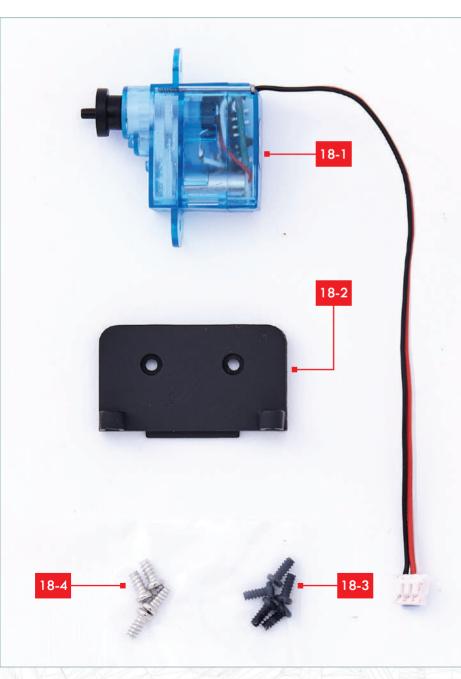
The skull is taking shape, and ball joints have been added to the palm of the hand.

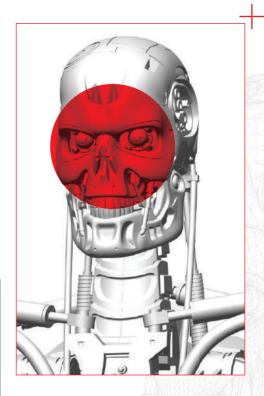
29

30

STAGE 18: ASSEMBLING THE EYE MOTOR SUPPORT

In this stage, you'll combine the existing head components with the eye motor, ultimately granting movement and control over the T-800's terrifying red eyes.





LIST OF PIECES

18-1	Motor for eyes
18-2	Eye motor support
18-3	5 x PB 1.7 x 4mm screws (1 spare
18-4	4 x PB 2 x 4mm screws (1 spare)

YOU WILL ALSO NEED

The head assembly from stage 02.

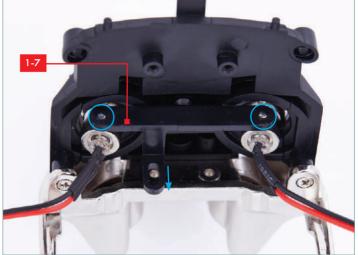
The neck and lower jaw assembly from stage 13.

A cross-head screwdriver.



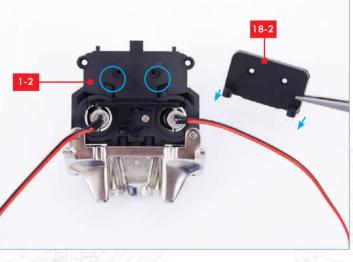
STEP 1

Take part 1-7, supplied with stage 01 and the head assembly from stage 03. Hold part 1-7 with the 'L' shape at the bottom, with the base of the 'L' pointing towards you. Fit the two holes in the top crossbar of part 1-7 over the two pins on parts 1-4, as indicated by the arrows.



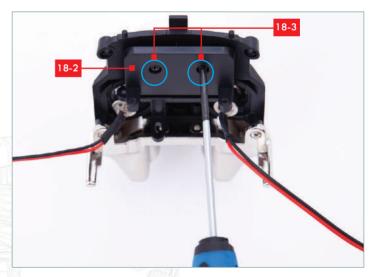
STEP 2

Viewed from above, you can see the two pins on parts **1-4** (circled) sitting in the holes in part **1-7**, with the base of the L pointing outwards (arrow).



STEP 3

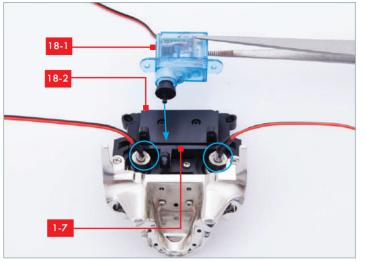
Fit the eye motor support **18-2** to the inside of the head so that the holes in part **18-2** are aligned with the raised screw sockets in part **1-2** (circled) and the brackets at the base of part **18-2** point towards you (arrows).



STEP 4

Fix the support **18-2** in place with two PB 1.7 x 4mm screws (**18-3**, circled).

31



STEP 5

Fit the motor **18-1** on its support **18-2**. The screw holes in the flanges on the sides of the motor align with the sockets in the two brackets on the support (circled). The pin on the end of the motor shaft fits into the loop in the base of the L of part **1-7** (arrow).



STEP 6

Fix the motor in place with two PB 1.7 x 4mm screws (18-3).

You may need to support the screw sockets on part **18-2** as you fix the screws in place.



STEP 7

This shows the motor fixed in place with the two PB 1.7 x 4mm screws (circled). The shaft on the motor is fitted into part **1-7** (inset).

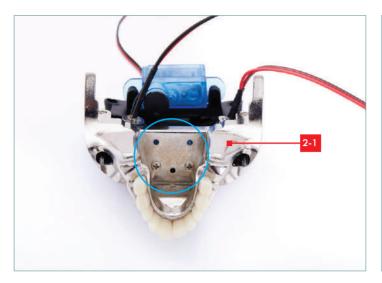




STEP 8

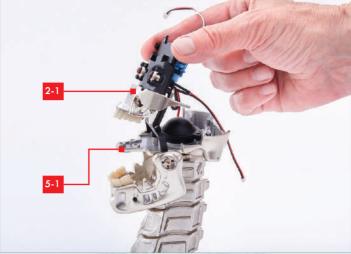
Take the lower jaw and neck assembly from stage 13. Identify the three screw sockets on the triangular tab at the front of the head (circled).

33



STEP 9

Identify the three screw sockets on the roof of the mouth in the assembly from step 05 (circled).



STEP 10

Postion the upper jaw (2-1) on the triangular tab (5-1) so that the screw holes in 5-1 are aligned with the screw sockets in the roof of the mouth on the upper jaw.



STEP 11

Fix in place with three PB 2×4 mm screws (**18-4**) screwing in from the lower side of the triangular tab.



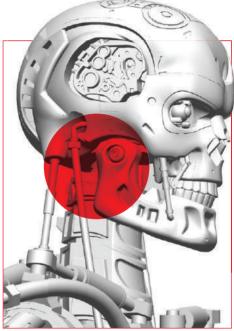
STAGE COMPLETE

The motor for the eyes has been fitted inside the head, and the upper and lower jaws have been attached to each other. 34

STAGE 19: ASSEMBLE THE HEAD MOTOR

Sync up the cogs and motor casing that will bring your T-800 TerminatorTM Endoskeleton to life.





LIST OF PIECES

19-1	Connecting cog assembly
19-2	Cog assembly housing
19-3	Motor housing
19-4	Motor
19-5	6 x PB 2 x 6mm screws (1 spare)
19-6	3 x PWB 2 x 6 x 5mm screws (1 spare)

YOU WILL ALSO NEED

A cross-head screwdriver.

35

STEP 1

19-1

Take the cog assembly **19-1** and the housing **19-2**. Check the fit of the assembly in the housing. The pin on one edge of the housing should be located in the socket on the cog assembly, as indicated by the arrow.

NOTE

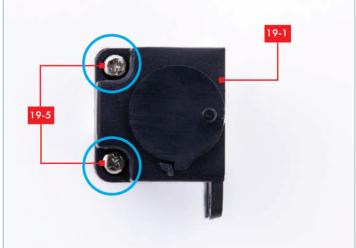
In some of the steps we have used tweezers to grip the parts. This is done for clarity in the photographs – it may not be necessary to use tweezers.



STEP 2

With parts **19-1** and **19-2** assembled, fix in place with two PWB $2 \times 6 \times 5$ mm screws (**19-5**).

19-2



STEP 3

The screws are positioned in the corners of the cog assembly as shown.





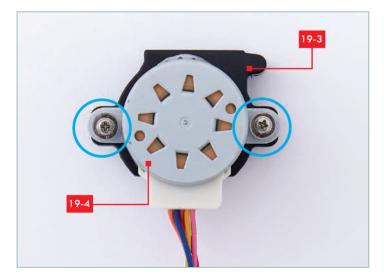
STEP 4

Take the motor **19-4** and the motor housing **19-3**. Align the tabs on the side of the motor with the screw sockets on the housing, as indicated by the arrow.



STEP 5

The raised sockets on the motor housing **19-3** fit through the larger holes on the tabs on the motor **19-4** (circled).



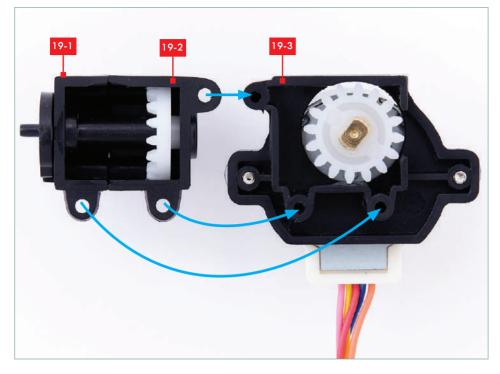
STEP 6

Fix the two parts together using two PWB2x6mm screws (**19-6**, circled).



STEP 7

Before proceeding, check the alignment of the peg on the cog assembly **19-1**: it should be positioned as shown, so that the wedge on the rotating disc butts up to the wedge on the housing.



STEP 8

Check the fixing points on the cog assembly and housing **19-1** and **19-2** and the motor housing **19-3**, as indicated by the arrows. The teeth on the two cogs will mesh together.





STEP 9

Fix the cog assembly and housing to the motor housing with three PB 2 x 6mm screws, **19-5** (circled).



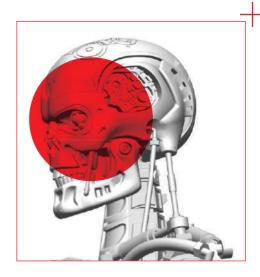
STAGE COMPLETE

The motor that will be positioned inside the head has been fitted into its housing and connected to the cog assembly.

38

STAGE 20: ASSEMBLE AND MOUNT THE HEAD MOTOR SUPPORT

The Terminator $^{\rm TM}$ Endoskeleton head takes shape, as you mount the motor unit inside it.





LIST OF PIECES

20-1	Motor support
20-2	Motor casing
20-3	Left-hand bracket

20-4	Right-hand bracket
20-5	3 x PB 2 x 6mm screws (1 spare)
20-6	8 x PM 2 x 4mm screws (1 spare)

YOU WILL ALSO NEED

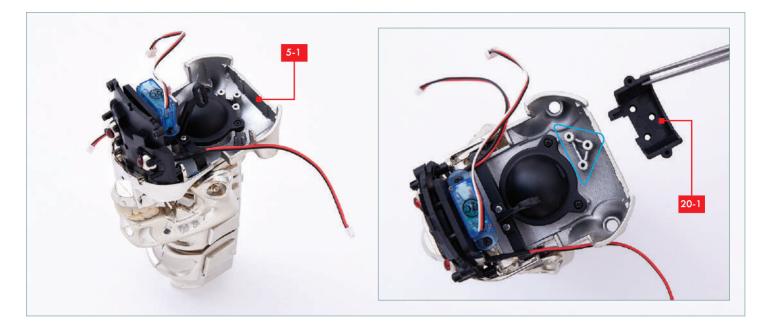
A cross-head screwdriver.

Tweezers.

The head assembly from stage 18.

The motor assembly from stage 19.

39

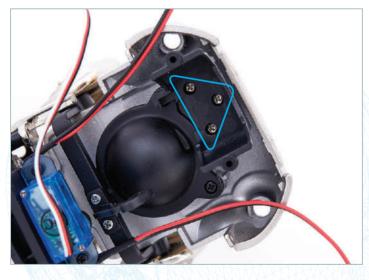


STEP 1

Take the head assembly from stage 18. Identify the three screw sockets (outlined) at the back of the head on part **5-1** (see inset). Align the screw sockets in the base of the motor support **20-1** with the screw sockets on part **5-1**.

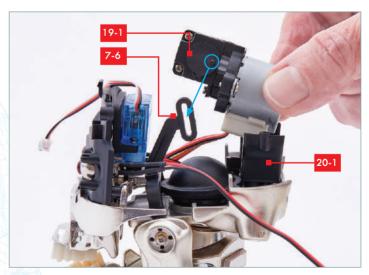
EXPERT TIP!

If the self-tapping screws are tight fit, it sometimes helps to repeatedly screw forwards a half turn followed by a quarter turn backwards until secure.



STEP 2

Fix the motor support **20-1** in place with three PM $2 \times 4mm$ screws (outlined).

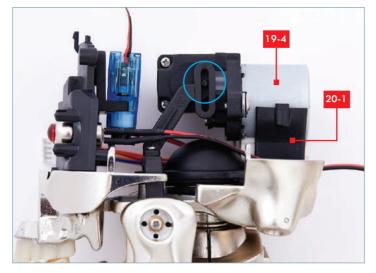


STEP 3

The next step is to fit the motor assembly from stage 19 into the motor support **20-1**. As you do this, the peg on the side of the motor housing (**19-1**, circled) must slot into the loop on the motor head joint **7-6**.

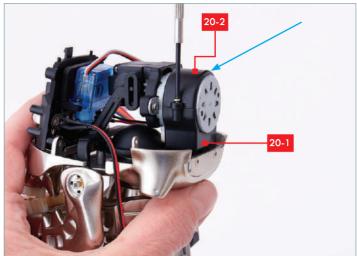


40



STEP 4

Fit the barrel of the motor **19-4** into the motor support, with the peg on the motor housing **19-1** through the loop.



STEP 5

Fit the motor casing **20-2** over the barrel of the motor. Note that one curved edge of the casing has a slight rib (arrow), which should go to the back of the motor. Fix in place with two PB x 6mm screws **20-5**.



STEP 6

Take the left-hand bracket **20-3** Note that the left-hand bracket has a screw socket on the upright arm close to the angle of the bracket (circled).



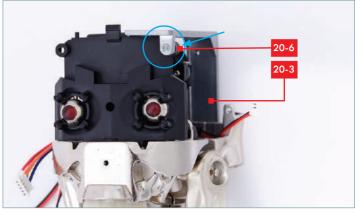
STEP 7 Align the bracket **20-3** with the top of the head.

41



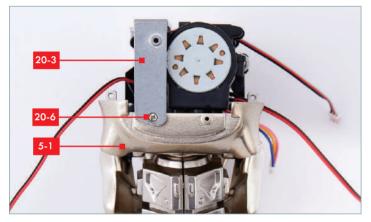
STEP 8

The tab with a screw socket at the front of the bracket **20-3** will fit in front of the screw socket at the top of the head (circled). There is a locating hole in part **20-3** which matches a locating peg on part **1-2**, shown above by the blue arrow.



STEP 9

Fix the front of the bracket **20-3** in place with a PM 2×4 mm screw **20-6** from behind, so that the flat end of the screw is flush with the front of the bracket.



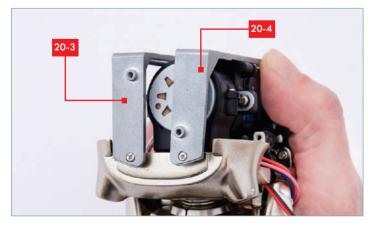
STEP 10

At the back of the head, the screw socket on the short arm of the bracket **20-3** should align with the screw socket in the back of the head on part **5-1**. Fix in place with a $PM2 \times 4mm$ screw **20-6**.



STEP 11

Take the right-hand bracket **20-4**. Again, it is easily identified because of the screw socket near the bottom of the shorter arm (circled).



STEP 12 Repeat steps 9 and 10 to fix the right-hand bracket **20-4** in place.



STAGE COMPLETE

The motor has been fitted inside the head and two brackets hold the parts of the head firmly in place.

SCI-FI CINEMA

42

IRON MAN

SELF-MADE CYBORG TONY STARK IS THE NEW FACE OF CHARISMATIC MAN-MACHINE INTERFACES.

Clad in red and gold armor, this futurist founding father of the Marvel Cinematic Universe has grappled with all manner of foes, from terrorism to alien invasions.

he first *Iron Man* was a major gamble on the part of Marvel Studios. A self-financed film starring a thirdtier Marvel Comics superhero, *Iron Man* was a chance to demonstrate just how popular the Marvel heroes could be when the studio was free to drill down to the essence of their characters, presenting them to a modern cinema audience with their core attributes intact.

There was to be no aggressive 'reimagining' of Iron Man for the movie, only a paring away of the cruft that had gathered around the character since his debut in *Tales of Suspense* #39, cover dated March 1963.

The movie charts Tony Stark's journey from capitalistic weapons manufacturer to metal-plated vigilante — a journey sparked by a traumatic experience in an Afghan cave, and the wise mentorship and steady hands of similarlycaptured scientist and engineer, Yinsen.

The experience gives Tony a new lease on life, a new source of energy in the form of a prototype arc reactor that stops pieces of shrapnel from penetrating his heart, and a suit of powered armor that allows him to escape his captivity in explosive fashion.

Once back in the USA, Tony uses iterations of the Iron Man armor to bring freedom to the world on a freelance basis... that is, as long as scheming members of his own company, led by the corrupt Obadiah Stane, don't steal his invention, leave him for dead, and pervert the Iron Man project in the name of profit!



SCI-FI CINEMA

43



REAL-WORLD FEEL

As director Jon Favreau noted, the key watchword for *Iron Man* was "plausibility" — this was a superhero movie that took place in the world outside your window. The audience had to believe that not only could Tony Stark fly — but that he could perform a perfect three-point superhero landing after crashing through the ceiling of their local mall.

By no means a sure bet, Favreau's experience with complex effects work, coupled to his facility as an actor (he also plays Hogan in the film), and his early actor-

FILM DATABLAST

Director: Jon Favreau

Screenplay: Mark Fergus & Hawk Ostby & Art Marcum & Matt Holloway Producers: Kevin Feige, Avi Arad, Victoria Alonso Composer: Ramin Djawadi Director of Photography: Matthew Libatique Editor: Dan Lebental Cast: Robert Downey Jr. (Tony Stark/Iron Man), Terrence Howard (Rhodey), Jeff Bridges (Obadiah Stane), Gwyneth Paltrow (Pepper Potts), Leslie Bibb (Christine Everhart), Shaun Toub (Yinsen), Faran Tahir (Raza) Clark Gregg (Agent Coulson), Paul Bettany (JARVIS), Jon Favreau (Hogan) Year: 2008 Duration: 126min Aspect Ratio: 2.39:1 Country of Origin: USA

producer work on dialogue-driven indie hits like Swingers, counted greatly in his favor.

He turned out to be the perfect combination, bringing a looser, improvisational feel to the dialogue, while his skill with mounting an action sequence and getting the best out of multiple effects houses led to fan-favorite sequences like Tony's escape from his desert captors, the freeway face-off between Iron Man and Iron Monger, and the jet fighter-versus-Iron Man aerial pursuit.

The other key piece of the puzzle was Robert Downey Jr. Always a charismatic presence, a troubled period in his personal life before the movie meant this was as much his story of redemption as Tony's. With him in place, the studio attracted all manner of star talent, from Gwyneth Paltrow as Tony's loyal partner, Pepper Potts, to Jeff Bridges as the looming, traitorous presence of Obadiah Stane.

EVEN WITH A CAST-IRON CAST AND CREW, IT WASN'T ALL SMOOTH, JARVIS-ASSISTED FLIGHTS WHEN THE MOVIE GOT UP AND RUNNING.

LAUNCHING THE ARMOR

Even then, production wasn't a smooth, JARVIS-assisted flight. The film reportedly started shooting with only an outline and no finished script, and major sequences, exchanges of dialogue, and even plot points were retooled on the fly — right down to the infamous moment where Tony reveals to the world: "I am Iron Man."

But the calibre of the creative team kept the film on track. The actors themselves were instrumental in shaping the rapidly-evolving script and their characters, with Downey Jr. embodying Stark's precocious intelligence on set.

Similarly, settling on the 'dark mirror' of Stane's hulking Iron Monger gave Iron Man a straightforward villain to confront — one birthed from the same weapons-focused hubris that led Stark to the cave, but with none of the selfknowledge he brought back from it.

Tony Stark's heart — or the humming arc reactor adjacent to it — may power his armor, but it's his change of heart that powers the film.

More importantly, to the energetic sounds of a rockdriven soundtrack, including an on-the-nose licensing of Black Sabbath's 'Iron Man', here was a superhero who wasn't conflicted about the act of being a hero.

After years of self-doubting vigilantes, here was a character who *loved* soaring through the sky, pushing himself as far and as high as he could, and trying to make the world a better place.

Audiences responded to the character and his iconic armor with delight, and a cinematic universe was born.

OPPOSITE: The red and gold Mark III Iron Man armor: the supersuit that launched a global megafranchise. (Photo: AF archive / Alamy Stock Photo)

ABOVE: Director Jon Favreau (right) encourages Robert Downey Jr. (left) to get more hands on with Tony Stark's inventions. (Photo: Entertainment Pictures / Alamy Stock Photo) SCI-FI CINEMA



ARMOR UP

Unlike the Terminator's endoskeleton, buried beneath the skin, Tony's armor is an exoskeleton which envelops his alltoo human frame.

As Tony's journey progresses, we see him struggle with his armor as a crutch, as a shield against fully engaging with the world, and as a means of dealing with post-traumatic stress disorder.

By the time of 2018's Avengers: Infinity War, Tony Stark may make putting on a suit of armor as effortless as tapping a chestpiece filled with nanites, but the building of the first suit is as analog as they come, a jerry-rigged fusion of desperation and spare parts.

JARVIS IN A BOX

Voiced by Paul Bettany, Tony Stark's prototype Al, JARVIS (Just A Rather Very Intelligent System) assists with the running of Stark's company, workshop, and suit. Though JARVIS would receive a sentience upgrade and a body in 2015's Avengers: Age of Ultron, in Iron Man, he is a mellifluous, sarcastic, and chiding presence who provides measured stability to Tony's runaway faith in his own scientific prowess. The bodiless ying to Tony's yang, this digital Jiminy Cricket is as essential a part of the Iron Man suit as Tony himself — to the extent that it could be argued that Iron Man is a cyborg fusion of three entities: Tony, JARVIS, and the suit.

Tony's armor manifests itself in multiple forms throughout the first film, from the rugged Mark I, welded together in secret and powered as much by fear and adrenaline as by the arc reactor embedded next to Tony's heart, to the red and gold Mark III, a lithe, hot-rod of a flying weapons platform.

Perhaps the most interesting element of *Iron Man* is how much screentime it devotes to Tony as scientist, inventor, and engineer. His journey is that of a self-*built* man reassembling the parts of himself that were shattered during the terrorist attack, consciously choosing what kind of person he will become. The various permutations of the armor track his progress visually and mentally.



METAL HEAD, DIGITAL HEART

In the movie, the suit of armor was visualized using a mixture of on-set partial costumes and computer generated imagery — a technique pioneered on Favreau's Zathura: A Space Adventure. Full figure shots of the armor were generally all CG, but in close-up shots and armor assembly sequences, Downey Jr. would be shot with a physical chest piece, with the helmet, gauntlets, and leg armor added in post-production.

HEADS UP

In a twist on the Terminator's Heads Up Display, or HUD, Iron Man takes us inside the Iron Man helmet to focus on Robert Downey Jr.'s performance as he and JARVIS interact, bicker, and run systems based on voice commands and eye cursors. The final HUD effect — made of complex motion graphics superimposed over greenscreen footage of Downey Jr. — was designed and visualized for the screen by FX house The Orphanage, based in San Francisco.

As the movies have progressed, and the suits of armor have become more ornate, Downey Jr. has worn fewer and fewer elements on set, to the extent that in *Infinity War* the suit is entirely computer-generated.

This is a result of not only the increasingly effects-heavy nature of the modern blockbuster (*Iron Man* featured 400 visual effects shots, while Avengers: *Infinity War* featured 2680), but also the increasingly fluid nature of the design work used in those films.

Key decisions about costumes are now often left entirely to the VFX stage to give concept artists longer time to refine the final look — and also to help secrecy-heavy productions avoid much-dreaded leaks and spoilers. ABOVE LEFT: Tony Stark prepares to test fire one of his repulsors, the technology that allows him to fly, but also project beams of force from his hands. [Photo: Moviestore collection Ltd / Alamy Stock Photo]

ABOVE RIGHT: Even after rapidly prototyping and 3D-printing the armor, Tony still needs to get hands-on in his workshop. (Photo: Entertainment Pictures / Alamy Stock Photo)



45



ROBOTIC ARMS: A SHORT HISTORY

The robotic arms of the T-800 are finely-tuned examples of engineering, the result of over a hundred years of refinement, further augmented by the Al-enhanced capabilities of Skynet.

n our own timeline, robotic arms have been in use in industry since the 1950s, and have expanded out into the fields of medicine, crewed spaceflight, and more. But their principal use has been on the factory floor, speeding up production lines by performing repetitive tasks too dangerous or too reliant on feats of impossible strength for humans to attempt.

Before we dive into the history of these wonders of engineering, it's important to note that a mechanical arm does not need to function independently of a human user in order to be classed as robotic. In fact, you can absolutely class the surgeons using robotic arms for operations in such fields as brain surgery as cyborgs, as their fusion of person and machine allows both to exceed what they could do on their own.

FROM FICTION TO REALITY

The dawn of the industrial robot can be traced back to a young engineering student from Toronto named Griffith "Bill" P. Taylor, who created an automated block-setting robot out of Meccano in 1937. Named 'The Robot Gargantua', this fully-working proof of concept was published in Meccano Magazine in 1938. Shaped like a crane, built from Meccano parts, and powered by a small electrical motor, it had five axes of movement, and could both grab items, and rotate what it had grabbed.

The arm could be programmed by punching holes in paper tape, which, when read in the manner of a player piano, turned on or off the current to a series of solenoids — coils of insulated wire that act as inductors in electronic circuits. These solenoids activated movement in the control

ABOVE: A pair of modern robot arms weld part of a car in an automotive factory. [Photo: Shutterstock] levers, and the programming allowed the crane to build towers of wooden blocks.

It would take another 22 years for this concept to become an industrialized reality. In 1954, inventor George Devol applied for the patent for the first industrial robot, an automaton which could stack objects and transfer them from one point to another, within a radius of 3.5 meters (11.5 feet approx.).

WHAT'S AN AXIS?

In the case of robotics, an axis is a practical measurement of a robotic arm's freedom of movement in a given direction within threedimensional space — along the X-axis (forward and backward), the Y-axis (left and right), and the Z-axis (up and down).

A robotic arm with six-axis capabilities can freely move (or be programmed to move) along each of these axes. Additionally, movements within these axes can be combined using rotation to create finer and more analogue movements.

The first industry-ready prototype — Unimate #001 — was installed at the General Motors die-casting plant in Trenton, New Jersey in 1959. It weighed over 1200kg (2645 lbs).

From this first prototype, and with the assistance and patronage of Joseph Engelberger, the director of the Consolidated Controls Corp. (himself a big fan of Isaac Asimov's *fictional* robots), Devol launched the company Unimation.

Unimation led to the Unimate 1900 series in 1961, the first mass-produced assembly line robot. The robot wowed the public and industry insiders alike at a parade of trade shows — and made its television debut on Johnny Carson's *Tonight* Show in 1966, pouring beer, playing 'office golf' into a cup, and conducting the house musicians.

THE ROBOTIC REVOLUTION

In 1969, General Motors rebuilt its Lordstown, Ohio automotive plant specifically around the concept of automated assembly, installing Unimate spot welding robots throughout. At a stroke, the robots more than *doubled* the production speed of any other car plant in the world at that time, with an ability to build 110 cars per hour.

Over in Europe, in 1975, the first fully electrically-driven robot was created by the ASEA — the General Swedish Electric Company. The ASEA IRB 6 also used the first chipset designed by Intel, making it the first microprocessorcontrolled arm. Nearly 2000 IRB 6s were sold between 1975 and 1992 — the first of which was bought by Magnussons to wax and polish stainless steel tubes.

The PUMA robot arm (Progammable Universal Machine for Assembly) was released in 1978 by Unimation and Vicarm,

and was developed by Victor Scheinmann based on the 'Stanford Arm' he created while at Stanford University. Long a significant fixture on assembly lines, the smaller model 200, the size of a desktop, also found use in the medical arena, being used for the first robotic stereotactic brain biopsy in 1985. As quoted by the New York Times on June 25, 1985, in that instance, "the robot device calculated the angles and held and directed a surgical drill and biopsy needle while the doctors applied the pressure on the instruments to penetrate the skull and brain". The robot in question was a PUMA 200.

THE UNIMATE 1900 MADE ITS TELEVISION DEBUT ON JOHNNY CARSON'S TONIGHT SHOW IN 1966, POURING BEER, PLAYING GOLF, AND CONDUCTING THE HOUSE MUSICIANS.

ENDLESS UPGRADES

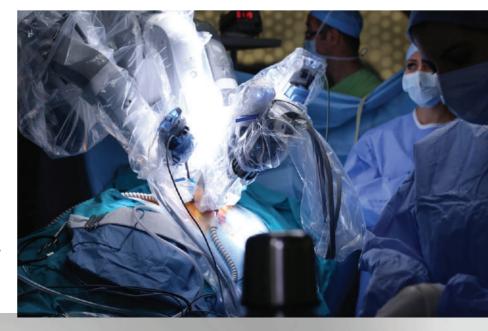
The first robotic arm with motors installed directly into the joint came in 1981, from Dr. Takeo Kanade. By internalizing these essential components, the arms' speed and accuracy were vastly increased.

From the 1980s to the present day, the complexity, precision, and facility of robotic arms has grown at an exponential rate.

Control systems, too, continue to get more accessible. What once required a phalanx of dedicated programmers can now often be programmed through a touchscreen app, and where robots used to be corralled away from the human employees behind safety walls, many companies are now using collaborative robots to share tasks between robots and humans on the same part of the factory floor.

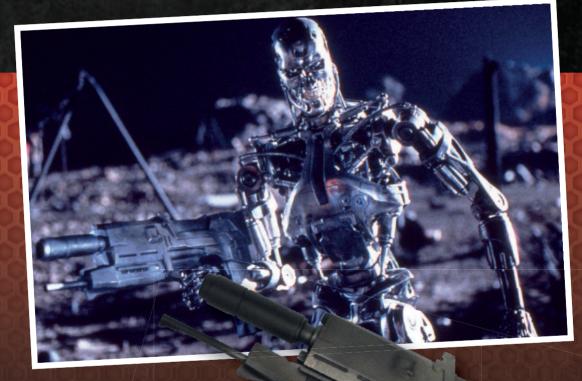
Unlike the Terminator, sensor technologies with automatic shut-off systems can immediately detect variances in robotic behavior that might put the humans working alongside them at risk, and thus allow humans and robots to work in harmony.

BELOW: The robot arms of the da Vinci medical system allow for minimally-invasive operations, where the skills of the surgeon are augmented by the precision of the robotics. (Photo: Shutterstock)



46

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