A tutorial for the Professor Pyraminx

**Introduction**

The *Pyraminx* is a very well known twisty puzzle that was invented by Professor Uwe Meffert 40 years ago. This tutorial will teach you an easy way to solve the *Professor Pyraminx*, especially for those of you who have solved the Pyraminx before. It uses a reduction method that reduces the more complex Professor Pyraminx to a much easier puzzle: the Jing’s Pyraminx (or Halpern Meier tetrahedron). This is similar to how a high order Professor Cube (5x5x5 Rubik’s Cube) can be reduced to a 3x3x3 Rubik’s Cube.

The Professor Pyraminx is a higher order Pyraminx and is manufactured by Meffert’s. The puzzle was originally designed by Timur Evbatyrov who produced a 3D printed version.

**The Pyraminx family includes:**

The **classic Pyraminx** which had its 40th anniversary in 2010.

The Jing’s **Pyraminx** was designed by Adam Cowen and was produced by Uwe Meffert in 2009. It is a pillowed Halpern-Meier pyramid, based on the Skewb mechanism.

The new **shape modification** of the *Pyraminx* by Adam G. Cowan and Timur Evbatyrov - 2011

**Jing’s Pyraminx, Jade** version - 2010
The Crazy Tetrahedron is a Circle Halpern-Meier Tetrahedron (several bandaged versions exist).

**Vulcano**, by Timur Evbatyrov - 2010

The Vulcano was manufactured by Meffert’s. The original name given to the 3D printed version was the Trignis.

**Master Pyraminx**, 3D printed version by Timur Evbatyrov - 2010

The Professor Pyraminx was designed by Timur Evbatyrov and manufactured by Meffert’s.

The names were coined after the higher order Rubik’s Cubes: the 4x4x4, or Rubik’s Revenge, is sometimes referred to as the Master Cube and the 5x5x5, is known as the Professor Cube.

It is easy to see that the tips of the Pyraminx, Master Pyraminx and the Professor Pyraminx are connected to just one piece underneath. They will always travel with this single 3-stickered piece. The two pieces together should be viewed as a whole corner of the tetrahedron. A simple turn of a tip will align it with the other part; therefore the tips are called “trivial tips”.

The Jing’s Pyraminx is cut differently than the original Pyraminx. Also, the centres of the Jing’s Pyraminx are connected to the core. You can view both the Jing’s Pyraminx and the Professor Pyraminx as a face turning puzzle, a vertex turning puzzle, or both. (*NB Mathematicians call this property self-dual.*) By introducing notation for both face and vertex moves this tutorial will be easier to understand.

If a Jing’s Pyraminx is solved like a Pyraminx, in most cases centres will need to be swapped at the very end. There is a relatively short and easy sequence to achieve this.

Many people familiar with twisty puzzles can already solve the original Pyraminx and the Jing’s Pyraminx. Therefore, this tutorial will use a `reduction method`, where a scrambled Professor Pyraminx is reduced to a Jing’s Pyraminx and then solved `as a Jing’s Pyraminx`.

If a Jing’s Pyraminx is solved like a Pyraminx, in most cases centres need to be swapped at the very end. There is a relatively short and easy sequence to achieve this.
These are the corners of the Jing’s Pyraminx:
They have been reduced by simply turning the trivial tips.

In our first step we will group the three central tips with the innermost centre piece.
These will become the centres of the Jing’s Pyraminx:

In our second step we will group the three central edge pieces to build the Jing’s Pyraminx edges.
After we have solved the reduced Jing’s Pyraminx, we will then go back and solve the remaining edge pieces in the final step.
In this step we will not build complete edges consisting of five pieces.
The reason for not solving these pieces yet will be explained later.

This is a diagram of the ordinary Jing’s Pyraminx:

Notice the relationship between the reduced Professor Pyraminx and the Jing’s Pyraminx.

Nomenclature, Notation and Diagrams

Nomenclature

In this diagram I have labelled all of the stickers on each specific piece type using the numbers 1 to 7

1. CENTRE: one sticker, in the centre of a face, (4 total)
2. CENTRE TIPS: one sticker, three on each face adjacent to the CENTRE; (12 total). When solved I call the combined group of 3 CENTRE TIPS and 1 centre piece a ‘BIG CENTRE’.
3. MIDDLE EDGES: two stickers, one in the centre of each edge, (6 total).
4. INNER WEDGE: two stickers; one pair of mirrored pieces per edge, adjacent to the MIDDLE EDGE, (12 total)
5. OUTER WEDGE: two stickers, one pair of mirrored pieces per edge, adjacent to the INNER WEDGES, one pair per edge, (12 total)
5. **CORNER**: three stickers, adjacent to the three **OUTER WEDGES**, these are the real corners (because the trivial tips can be aligned by a simple twist). The trivial tips are solved in step 0 and after that they are not turned again while solving. (4 total)

6. **TRIVIAL TIPS**

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**Notation and Diagrams**

We will use three types of diagrams: The Pyramid is in all cases viewed as if it were sitting flat on a table. This diagram shows one tip pointing upwards and one tip pointing towards the viewer: In some cases we will reveal a few hidden stickers at the side of the pyramid like this.

In this diagram we view the pyramid from above, looking down on the upward pointing tip: It shows three faces but the fourth is completely hidden.

In cases where it is important to see all four faces we will use two connected diagrams: The colours on the diagrams match the standard sticker colours of the Professor Pyraminx.

The arrows in diagrams indicate where pieces will travel to when a given sequence is applied.
The names of the four faces are shown here:
L = Left
R = Right
B= Back
D= Down

We will use vertex moves as well with these names:
U = UP
F = Front
L = Left
R = Right

Because we will be using the same letters for face turns and vertex turns, we will use a suffix v, when we describe a vertex move.

**Move notation**

We will not use a notation for the turning of the TRIVIAL TIPS. On our right, we can see a clockwise turn of a CORNER (a vertex turn) $U_v$.

Most of the time it will be convenient to turn some inner layers with a CORNER during a vertex turn. In general we will use a number and two letters to denote a move: $\{1,2,3\} X \{f,v\}$

When $X$ is a capital letter it will represent a face or a CORNER turn ($L, R, B, D, U, F$). A corresponding lowercase letter will be used for inner slice turns ($l, r, d, u, f$).

The number will represent how many layers are turned along with the face / CORNER (not including the TRIVIAL TIPS) and the suffix $\{f / v\}$ denotes a face or vertex turn.

The number 1 and suffix f will be the default and will usually not be written.

A little graphic may be provided along with the notation, like this: $^2U_v$

The layer under the CORNER $U$ is the slice $u$ (lower case).

Notice that the diagram on the right could represent either
a face turn $D$ or a vertex turn $^{3}U_{v}$ (we will call this a turn of the whole pyramid tip). The result will be the same, but the orientation of the puzzle afterwards will be different. When a $D$ turn is made, the top part of the pyramid will remain stationary and the base will move around. Alternatively when a $^{3}U_{v}$ turn is made the base will remain stationary while the upper part of the pyramid (the whole pyramid tip) will move around.

Some more examples:

$^{3}U_{v}$

$D$

$d$ is the inner slice layer above the $D$ face. It will turn in the same direction as the $D$ face. So, both $D$ and $d$ are clockwise turns.

Face turn: $R$ clockwise

In standard Twisty Puzzle notation a apostrophe ($'$) represents an anticlockwise turn and it’s absence represents a default clockwise turn.

$^{2}F_{v}^{'},$ Vertex Turn: $F_{v}^{'},$ and inner slice anticlockwise.

You’ll find a table with many more moves at the end of the Addendum (at the end of this document)
**Notation for the location of pieces**

<table>
<thead>
<tr>
<th>CENTRES</th>
<th>Designated by the face names L, R, B, D</th>
</tr>
</thead>
<tbody>
<tr>
<td>CENTRE TIPS</td>
<td>Designated by the face name and the corresponding vertex e.g. Ru or Lf</td>
</tr>
<tr>
<td>MIDDLE EDGES</td>
<td>Designated by the edge names. An edge name consists of the two adjacent face names e.g. RL or RD</td>
</tr>
<tr>
<td>INNER WEDGES</td>
<td>Designated by <strong>edge name and inner layer</strong>- below a vertex e.g. Rlf or LDF</td>
</tr>
<tr>
<td>OUTER WEDGES</td>
<td>Designated by the edge name and the corresponding vertex layer e.g. RLU, or RDF</td>
</tr>
</tbody>
</table>

**General outline**

The Professor Pyraminx is the most complex Pyraminx available as a mass-produced puzzle, today. Many puzzlers have solved the normal Pyraminx and the Jing’s Pyraminx. These are relatively easy twisty puzzles.

Therefore, we will reduce the more complex Professor Pyraminx to an easier puzzle, the Jing’s Pyraminx. Solving the Jing’s Pyraminx is either already known or relatively easy to learn. For those of you who have never solved a Jing’s Pyraminx, a brief solution will be described.

This reduction method is very similar to the method most people use to solve the 4x4x4 cube. They build centres and edges and then solve the 4x4x4 cube as if it were a 3x3x3 cube.

We will solve the Professor Pyraminx in four steps (not counting the TRIVIAL TIPS)
- **Step 0:** TRIVIAL TIPS: Just twist the tips until they are aligned with the CORNER piece underneath.
- **Step 1:** Pair the CENTRE TIPS with the correct CENTRES building the BIG CENTRES.
- **Step 2:** Pair the MIDDLE EDGES with the INNER WEDGES.
- **Step 3:** Solve the reduced Halpern-Meier Tetrahedron (or Jing’s Pyraminx
- **Step 4:** Solve the OUTER WEDGES.

If you have never solved a Jing’s Pyraminx before, and your Professor Pyraminx is not yet scrambled, it may be a good idea to scramble it just using outer face moves (which will scramble it like a Jing’s Pyraminx) and go to Step 3.

**Step1: Pair the Centres with the Centre Tips**

When we finish this step, the four CENTRE pieces will be surrounded by their three corresponding CENTRE tips.

**TIPS:** We will call the combined 4 triangles the BIG CENTRES.

We will ignore all of the other piece types at this stage.

We will do one CENTRE TIP at a time.

We will adhere to the following principles:
- We locate a target face with a target CENTRE piece.
- We turn another face with a corresponding target piece into such a position that it will turn into its correct place with a single vertex turn.
- We do a turn to join a CENTRE TIP with its CENTRE. This will always involve an inner slice turn.
- We then turn the target face in such a way that the newly placed CENTRE TIP is replaced by an incorrectly placed CENTRE TIP.
- Last we reverse the first move.

Most of this can be done intuitively, especially for the first two BIG CENTRES. We will illustrate this with a few pictures. Here is a completely scrambled Professor Pyraminx:

This looks really confusing, right? That’s why we do it step by step.

We will concentrate on one BIG CENTRE at a time. We turn the whole Professor Pyraminx until the target CENTRE is on L face. We turn faces until we have set up a situation like the one in the diagram:

The diagram shows a specific situation for the orange and blue faces, but you can use it as a template for placing all CENTRE TIPS. We can repeatedly setup the same situation for placing all CENTRE TIPS.

A wrong CENTRE TIP is on the L face, in the d layer. It is the light grey triangle $\downarrow$ in the $L_f$ position.

The dark grey triangles $\uparrow$ represent CENTRE TIPS that will remain on the respective face when we have finished the following sequence. They may or may not be correct yet.

The other two BIG CENTRES are not changed at all during this sequence. We finish now all four BIG CENTRES by pairing one CENTRE TIP at a time with its correct CENTRE by repeating this setup and the sequence $^{2}U_{w}, L', ^{2}U_{v'}, L$.

**Step 2: Build Edge Triplets by Pairing Middle Edges with Inner Wedges**

After this step we will have paired the six triplets as shown in this picture. We do not care at all, where they will be located relative to the BIG CENTRES and CORNERS. The Professor Pyraminx will still look scrambled, but all BIG CENTRES and all edge triplets will be paired.

We will start by looking for existing half pairs where a MIDDLE EDGE is paired with one correct INNER WEDGE already.
If we cannot find any half pair, we build the first half pair

We choose an **INNER WEDGE** at \( LRf \) (green orange in the example) and place the fitting **MIDDLE EDGE** at \( RB \).

We pair these two pieces by \( \mathbf{2U_v} \)

This destroys some **CENTRE TIPS** so we will need to reverse the \( \mathbf{2U_v} \) turn later.

We move the new half pair down to the \( D \) layer with an \( \mathbf{R} \) turn.

Then we exchange it with an unpaired triplet by making a \( \mathbf{D} \) turn

Returning the face with the broken **BIG CENTRE** with a \( \mathbf{R} \) turn

The newly built green/orange half pair is now safely (invisible on the diagram) at edge \( DB \)

The last \( \mathbf{D'} \) is not necessary, but we now have the new half pair on the \( RD \) edge and we can show it in the next picture

Similarly, we can join the mirrored orange/green **INNER WEDGE** with the new half pair. We set the pieces up (by turning the whole cube and outer faces only) like this:

We repeat the same move sequence as above: \( \mathbf{2U_v}
\ \mathbf{R'}, \ \mathbf{D}, \ \mathbf{R}, \ \mathbf{D'}, \ \mathbf{2U_v'} \)

We can now establish certain rules for pairing the edge triplets:

1. We look for the pieces we want to join and turn the whole Professor Pyraminx and outer faces to a convenient position where we can either join two or three pieces of the triplet.
2. We do an inner layer move to do the pairing (conveniently on the RL edge). This will destroy some paired **BIG CENTRES** for the moment. This inner layer can be a layer below a **CORNER** – in the same
way as we have used it above – or alternatively a layer below a face. We will use this in the next example.

3. We will replace the newly paired edge pieces with another edge containing incorrect pieces.

4. We will reverse the inner layer turn to restore the BIG CENTRES again.

In case you prefer a fixed move sequence, I have provided the following 8 move sequence. We execute it on a solved Professor Pyraminx. Comparing the two diagrams allows for an easy understanding of how the pieces of interest move.

\[
d, R', D, R, \\
d', R', D', R
\]

We ignore the OUTER WEDGES and notice the 3-cycle of the three INNER WEDGES:

\[
RLf \rightarrow LDf \rightarrow LBd \rightarrow RLf
\]

Please note, that the last 3 moves in this sequence are not necessary, because we do not care about positioning the paired triplets.

It is just easier to visualize what has happened when performing them as well.

Here are the 8 moves \(d, R', D, R, d', R', D', R\) as pictograms:

The setup is the following:

The dark grey triangle \(\square\) stands for `may be correct or not`. The INNER WEDGES and MIDDLE EDGES will stay together. Purple triangle \(\triangle\) stands for `an incorrect inner wedge`.

Hold the target MIDDLE EDGE at RL. The INNER WEDGE at RL may or may be not correct already.

Place the INNER WEDGE belonging to RLf at the location LBd.

Now do the five moves \(d, R', D, R, d'\),

The mirrored setup would be:

Hold the target MIDDLE EDGE at RL. The INNER WEDGE at RL may or may be not correct already.

Place the INNER WEDGE belonging on RLf at the location RBd.

Now do the five moves \(d', L, D', L', d\)

The white arrows indicate how the three inner wedges will move around within the three changed triplets. Their final location is not shown.
This is the mirrored sequence represented as a complete 3-cycle:
\[ d', L, D', L', d, L, D, L' \]

We go on building half pairs (a MIDDLE EDGE and one INNER WEDGE) and full triplets (a MIDDLE EDGE and the two adjacent INNER WEDGES).
Take care to avoid the destruction of already built half pairs.

In the example on the right, we would destroy the blue/green half pair on the RD edge using the sequence
\[ d', L, D', L', d \] as above

A little adaptation helps.
We do \( D' \)

and change our replacement moves to
\[ R', D, R \]

and complete the inverse of the inner layer turn with \( d \).

The last two or three triplets may need special care. We should try to achieve a situation where we have three half pairs when solving the last three triplets. A 3-cycle as above will then solve all remaining triplets.
It may happen that we have four solved triplets and two still mixed, like in the following example:

We pair the orange MIDDLE EDGE RL with INNER WEDGE Rbd by performing \( d' \). Now we flip the edge RL. We move the edge away and bring it back with the new orange/green half pair in the upper part of RL edge (MIDDLE EDGE flipped, INNER WEDGE at RLu) by performing \( R', D', R, D, L, D', L' \)

and then reverse the inner layer turn by performing \( d \)
Another case: Here we destroy one triplet temporarily by

$$d', R', D, R, d, D'$$

and have a situation with three half pairs:

We solve this by another 3-cycle

$$d', L, D', L', d, D:$$

The last case with two mixed triplets is:

We could assume that we need to swap the MIDDLE EDGES at RL and LB, but this would mean an odd permutation of two pieces, which is not possible.

Instead, we need to swap the four INNER WEDGES:

We can do this in two 3-cycles with some setup moves

NB: If you are not familiar with the term ‘setup moves’, please, have a look at the end of the Addendum.

setup move r':

$$d, R', D, R, d', R', D', R, r$$

3-cycle as described above, with the inverse setup move r:

Two setup moves b, D

Now we need this 3-cycle:

We do $$d, L, D', L', d', L, D, L'$$ and reverse the setup moves by

$$D', b'$$

Here is the whole move sequence (22 moves) in notation:

$$r', [d, R', D, R, d', R', D', R], r,$$

$$b, D,$$

$$[d, L, D', L', d', L, D, L'],$$

$$D', b'$$
And here it is in pictograms:

Please note, that the two 3-cycles in [] are almost mirrored, but the inner layer moves $d$ and $d'$ are not.

**Step3: Solve the Jing’s Pyraminx**

We now have a situation like this:

![Image of Pyraminx with all big centres paired and all inner wedges paired with middle edges.]

All **BIG CENTRES** are paired.

All **INNER WEDGES** are paired with the **MIDDLE EDGES**.

We can do the **OUTER WEDGES** now or alternatively, we can leave this for later.

If we do them now, we might get the following situation that is impossible on a normal Jing’s Pyraminx:

Repairing this situation requires reassembling the **OUTER WEDGES**.

Therefore, we progressively solve the Professor Pyraminx to a state like this:
ignoring for now the placement of the OUTER WEDGES.

We start with a little preamble that will avoid the mentioned situation where we would need to make a 3-cycle of BIG CENTRES in the last step. (If you ever get this specific state, you’ll find a complete move sequence for solving it in the Addendum.)

With a few simple moves we will group three CORNERS around one BIG CENTRE. In this example we choose the orange BIG CENTRE and the three orange CORNERS (Triangles represent correct pieces that we have built, and we will take care not to destroy, but we will not place them in their position yet. Triangles represent OUTER WEDGES that we will ignore for the time being.

We do $F_v$ and have the orange/yellow/blue CORNER correct at $F$, by performing $B'$ we place the orange / green / yellow CORNER in the location $U_v$ and the orange / blue / green CORNER in the location $L_v$. $L_v'$ turns the CORNER $L_v$ and we have arranged the orange CORNERS around the orange big centre:

We recognize that the green BIG CENTRE does not fit with the correctly placed CORNERS at $F$ and $U$. We align the green / blue / yellow CORNER at $R$ with the green BIG CENTRE by performing $R_v$ and turn the whole pyramid tip at $R$ by performing $3R_v$. Now we have all CORNERS and BIG CENTRES correct.

If you forget about this preamble, you can either execute a sequence 24 moves long (described in the Addendum) or, alternatively, you do not need to learn anything additional if you just start step 3 again. It will not be catastrophic because you will already have solved three of the six edges.
From now on, we will only use face turns (or whole pyramid tip turns like $^3R_v$, which is essentially the same thing).

Our work horse will be this sequence:

$$3F_v, 3L_v', 3F_v', 3L_v$$

![Diagram](image)

After you have done this sequence the big centres will be double swapped. We will ignore the big centres for the moment. If necessary we will do a 12 move sequence, after all edges (edges triplets) are placed correctly, to place them. We will see this in a moment.

If we have aligned the corners and big centres correctly as described in the preamble above, we will never need anything else other than this double swap. This is the effect of $^3F_v, ^3L_v', ^3F_v', ^3L_v$ on a solved professor pyraminx:

![Diagram](image)

We neglect the double swap of the big centres and see a 3-cycle of the three complete edges on the D face: $RD \rightarrow LD \rightarrow BD \rightarrow RD$ (looking directly at the D face it is an anticlockwise 3-cycle, but because we are looking at the diagram from above it may at first appear to be a clockwise 3-cycle). All other pieces remain in their original locations.

In the mirrored version:

$$^3F_v', ^3R_v, ^3F_v, ^3R_v'$$

we get a clockwise 3-cycle $LD \rightarrow RD \rightarrow BD \rightarrow LD$

$RD$ (tripliet 1) $\rightarrow LD$ (2) $\rightarrow BD$ (3) $\rightarrow RD$ (1)

We can interpret the sequence $^3F_v, ^3L_v', ^3F_v', ^3L_v$ as:

The first turn puts the RD edge (tripliet 1) into the spot LD. The second turn moves it (tripliet 1) out of the way, and replaces it with the BD edge (3). The third turn takes this edge (3) out of its spot, and the fourth turn replaces the former edge piece RD (1) back into its place at LD.

Regarding the yellow D face, the edge originally at BD and going to RD (or LD in the mirrored sequence) stays orientated (with the yellow on the D face).

The other two edges (triplets 1 and 2) are flipped (the yellow is no longer on the D face).

At least one of the three triplets involved must go to its correct destination.
This short and easy to learn sequence can solve all edges of the Professor Pyraminx / Jing's Pyraminx. We will look at a few examples and some special cases, when two or three edges are still mixed up.

**example 1:**

Please be aware that the colours of the **CORNERS** define the colours of the faces, **not** the colour of the **BIG CENTRES** yet. Edge **BD** needs to go to the spot **RD** without flipping (**D** face = green)

we do

\[ 3F_w, 3L_v', 3F_v', 3L_v \]

and have solved one edge at **RD**:

![Diagram](image1)

**example 2:**

\[ 3F_w, 3L_v', 3F_v', 3L_v \]

All edges are in the correct places, but **LD** and **BD** need **flipping**

we do a 120 degree anticlockwise turn of the whole Professor Pyraminx

we do

\[ 3F_v', 3R_w, 3F_w, 3R_v' \]

and now have a situation that can be solved by another 3-cycle

and now we can solve all edges with

\[ 3F_w, 3L_v', 3F_v', 3L_v \]

all edges are correct:

![Diagram](image2)
In this case we have all edges in the **D** face placed correctly, but we need to cycle \( BR \rightarrow BL \rightarrow LR \rightarrow BR \).

Our move sequence cycles three edges on a face; therefore, we can turn the whole Professor Pyraminx and do two setup moves so that we can solve this situation.

The whole Professor Pyraminx is turned until two **incorrect** edges are on the **D** face (orange). The third incorrect edge at **RL** needs to replace the correct edge at **DB**. We want to position the **orange** on the orange / blue edge on the orange **D** face. We do two setup moves \( \text{3U} \_ \_ \text{B} \)

Now we do our move sequence:

\[ 3F_v, \text{ } 3R_v, \text{ } 3F_v, \text{ } 3R_v \]

We have moved the three incorrect edges in such a way that the two edges at **RD** and **LD** are correct now (Please keep in mind that only the **CORNER** \( F_v \) has not been moved by our setup moves). By necessity, the third must be correct too, when we reverse the two setup moves by performing \( B^\prime, \text{ } 3U_v \).

It is not very hard to remember the two setup moves. Still, it needs some concentration and the Professor Pyraminx must keep the same orientation in space after the 4 move sequence. Otherwise you can get lost when trying to reverse the setup moves.

Doing setup moves in the ideal way takes practice.

If you still need two edges flipped, like in the previous case, this is achievable too.

The good news is: You will **never** need to do more than two setup moves.
The **last example** needs one setup move:

Three edges are correct (at DB, RB and RL), three edges are incorrect at LD, RD and LB. We do the setup move **B** (the blue of the blue / yellow edge will go to the blue D face and BD will go to LD without flipping) then we do our move sequence

\[3F_v', 3R_v, 3F_v, 3R_v'.\]

and reverse the setup move by performing **B'**

When we have finished the edges, we may need to swap the **BIG CENTRES**.

This is done by repeating our move sequence three times.

In this situation we need to swap the **BIG CENTRES** at D (the invisible green **BIG CENTRE**) with L (orange) and D (yellow) with R (blue).

\[\{3F_w, 3L_w', 3F_w', 3L_w\} \times 3\]

(x3 means to execute the 4 moves in brackets 3 times)

Finally, before we go to the last step, here is a 17 move sequence, in case you have messed up the **BIG CENTRES** by neglecting the preamble for this chapter. (In the Addendum you’ll find a complete version with 7 more moves, which leaves the **OUTER WEDGES**, untouched as well).

This sequence does a 3-cycle of **BIG CENTRES** (it is only needed if you have forgotten the preamble of this chapter):

The yellow face at D is correct but the other **BIG CENTRES** need an anticlockwise 3-cycle:


### Step 4: Complete the Outer Wedges

We now have a Professor Pyraminx similar to this one:

The **OUTER WEDGES** are visible on this diagram too, where `invisible` stickers are revealed at the sides of the pyramid.
This last step, placing the **OUTER WEDGES**, is relatively easy. We recognize that an **OUTER WEDGE** is at an intersection of a **CORNER** turn and an inner layer turn (directly below a face) like here:

This **OUTER WEDGE** is at $U,v$ and sits at the intersection of an inner face move $I$ and a **CORNER** move $U_v$.

The move $U_v$ changes only this single piece in the layer $I$.

3-cycle needed:

1 -> 2 -> 3 -> 1

This allows an easy construction of pure **OUTER WEDGE** 3-cycles. ('pure' means that everything else remains unchanged besides the intended 3 pieces) E.g. $r, U_v, r', U_v'$

1. piece 1, **OUTER WEDGE** $F,r$, goes to the position $U,r$ where it belongs and replaces piece 2
2. piece 1 is replaced by piece 3 and piece 1 is removed from layer $r$
3. piece 3 goes to the position $F,r$ and piece 2 returns to the position $U,r$
4. the **CORNER** turn is reversed and the 3-cycle is finished

At least one of the three 1, 2 or 3 should arrive in its correct position. Either 1 in the position of the former 2, or 2 in the position of the former 3, or 3 in the position of the former 1.

In some cases two or three **OUTER WEDGES** will become correctly placed.

There are many variants of the sequence (mirrored, inverse, with other **CORNERS** and with other inner layers involved) that are possible and sometimes **CORNER** setup moves are necessary.

These setup moves are easy to reverse, because not much is changed on the whole puzzle by doing just a **CORNER** turn.

Here are a few examples (where one of the three pieces 1, 2 or 3 will go to the correct position):
We continue:

\[ \begin{align*}
&\quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad.
One final example:

$I, U_v^\prime, I^\prime, U_v$

We do two setup moves $U_w, L_v^\prime$

We reverse the setup moves by performing $U_v^\prime, L_v$

The End

Written by Konrad from the twisty puzzles forum http://www.twistypuzzles.com

Thanks to Burgo and bmenrigh for all your help!
Addendum

List of sequences:

1. **CENTRE TIPS:**
   a) **CENTRE TIPS** in step 1

   \[ U_w, L', U'_v, L \]

   It is not necessary to perform the last \( L \) but it makes it easier to visualize how three **CENTRE TIPS** have been cycled.

   b) Pure 3-cycle of **CENTRE TIPS**
   (only used for repairing a mistake)

   \[ b, d', b', d, r_w, d', b, d, b', r_v' \]

2. **TRIPLETS OF INNER WEDGES AND MIDDLE EDGES**
   a) 3-cycle

   \[ d, R', D, R, d', R', D', R \]
b) double swap of two pairs of edges
$r', [d, R', D, R, d', R', D], r, b, D, [d, L, D', L, d', L, D, L'], D', b'$

Please note, that the two 3-cycles in $[]$ are almost mirrored, but the inner layer moves $d$ and $d'$ are not.

1 -> 2 -> 1; 3 -> 4 -> 3

3. Jing's Pyraminx

a) 3-cycle of edges in the D layer
The effect of $^2F_v, ^3L_v', ^3F_v', ^3L_v$

Professor Pyraminx:

b) Double swap of big centres
We need to swap BIG CENTRES at D (the invisible green big centre) with L (orange) and D (yellow) with R (blue).

$[^2F_v, ^3L_v', ^3F_v', ^3L_v] x3$

(x3 means to execute the 4 moves in brackets 3 times)
4. **Outer Wedges**

\[ r, U_v, r', U_v' \]

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**Move table**

This table shows all of the moves used in this tutorial, in both letter and pictogram form:

- \( B \) \( B' \)
- \( R' \) \( R \)
- \( r' \) \( r \)
- \( d' \) \( d \)
- \( r_v \) \( r_v' \)
- \( ^2U_v \) \( ^2U_v' \)
- \( ^2F_v \) \( ^2F_v' \)
- \( ^2L_v' \)
- \( ^2U_v \)
- \( ^2L_v' \)
- \( ^2U_v' \)
Setup move sequences create a specific situation, where a certain following move sequence can achieve an intermediate goal (e.g. a cycle of three pieces). After this, the setup moves are reversed (in some cases, in an early stage of the solving, this is not necessary). If we name the setup move sequence by \( X \) and the intended move sequence \( Y \), the whole operation will be \( X, Y, X' \) (\( X' \) = inverse of \( X \)). \( X \) may have an effect only on pieces that are not changed by \( Y \), or pieces we do not yet care about.

When we have learned a move sequence \( Y \) and what it does to the puzzle, we can vary our move sequences easily by the usage of setup moves. In cuber’s terminology, this is called a **Conjugation**.

E.g. you have learned the sequence \( 3F_v, 3L_v', 3F_v', 3L_v \) (solving the edges of a Pyraminx) and you can enhance your repertoire by using setup moves.

(Also, this kind of sequence \( 3F_v, 3L_v', 3F_v', 3L_v \) is called a commutator. Any sequence of type \( A, B, A', B' \) is a commutator. In this case \( A = 3F_v \) and \( B = 3L_v' \).)

In general, commutators combined with conjugation are powerful tools for your twisty puzzle solving tool chest.