

# A Computer Analysis of All 6-Piece Burrs

by Bill Cutler



billcutlerpuzzles.com

## [6-Piece Burr Analyses](#)

### [Acknowledgements](#)

- I. [Overview of 6-Piece Burr Analyses](#)
  - A. Introduction
  - B. Solid Analyses
  - C. Computers & Burr-Disassembly Programs
  - D. NOTC - Notchable, Holey Analysis
  - E. HB6 - General, Holey Analysis
  - F. Computer Time & the Four-Color Problem
  - G. Availability of Computer Results
- II. [The Pieces](#)
- III. [Constructing the Assemblies](#)
  - A. Symmetry of Assemblies
  - B. Choice of Construction Method
  - C. The Basic Logic
  - D. The 534 Cases
  - E. The Remaining Cases
- IV. [Analyzing Assemblies for Take-Apart](#)
  - A. The GENDA Program
  - B. Analyzing Movement in One Direction
  - C. The FDA Program
  - D. The LL Format
- V. [Testing for Uniqueness and Complete Disassembly](#)
  - A. Analysis of Interesting Assemblies
  - B. Apart-Codes
  - C. The AF Format
- VI. [Cataloging Different Take-Apart Methods](#)
- VII. [Is there Anything Else to do?](#)
  - A. Standard Pieces, Standard Moves
  - B. Standard Pieces, Non-Standard Moves
  - C. Non-Standard Pieces

### [VIII. Examples](#)

#### [References](#)

#### [Definitions](#)

#### [Figures](#)

#### [Tables](#)

Copyright 1994 & 2000

**Bill Cutler Puzzles, Inc.**  
All rights reserved.

[Home](#)  
[About our Puzzles](#)  
[How to Order](#)

[Six Piece Burrs](#)  
[Rectilinear Burrs](#)  
[Non-Rectilinear Burrs](#)

[Box-Filling Puzzles](#)  
[Miscellaneous Puzzles](#)  
[Computer Programs](#)

[Booklets](#)  
[References](#)  
[Other Websites](#)

Copyright 2000-2002 Bill Cutler Puzzles, Inc.

# Analyses



billcutlerpuzzles.com

[Contents](#)
*next:* [Acknowledgements](#)

Name	Size	Author	Date	Runtime
Notchable, Solid "JRM"	314 solutions	Bill Cutler & Tom O'Beirne (manual & computer)	Fall 1974	
General, Solid "SCIAM"	119,979 solutions	Bill Cutler (computer) & Arthur Cross (random manual checking)	Winter 1975	5 minutes on IBM mainframe
Notchable, Holey "NOTC"	13,354,991 assemblies	Bill Cutler (computer)	March 26, 1987 to June 6, 1987	2 months on PC AT
General, Holey "HB6"	35,657,131,235 assemblies	Bill Cutler & others (computer)	October 1987 to August 4, 1990	Equivalent of 62.5 years on PC AT

This booklet describes the last two analyses and the massive computer effort required to accomplish this task.

[Contents](#)
*next:* [Acknowledgements](#)
[Home](#)
[Six Piece Burrs](#)
[Box-Filling Puzzles](#)
[Booklets](#)
[About our Puzzles](#)
[Rectilinear Burrs](#)
[Miscellaneous Puzzles](#)
[References](#)
[How to Order](#)
[Non-Rectilinear Burrs](#)
[Computer Programs](#)
[Other Websites](#)

Copyright 2000-2002 Bill Cutler Puzzles, Inc.

# Acknowledgements



billcutlerpuzzles.com

[Contents](#)

*previous:* [Analyses](#) *next:* [Overview of Analyses](#)

The analysis presented in this booklet would not have been possible without the assistance of many people who contributed their time and computer power. In particular, Harry Nelson and his Cray computers at Lawrence Livermore Labs were responsible for about 40% of all of the computer time used on the project. Additional special thanks go to Matti Linkola of FINLAND, and the Research & Development group at CR Industries and their timely purchase of four 386 PC's. The people who assisted in the project are listed in more detail in [Table 13](#) in the Appendix. With all of their help the project was converted from a 62.5 year project on my one machine into one which was finished in about 2.5 years.

Special thanks also go to Rex Shudde, who used PCTEX and PICTEX to typeset this booklet and made many helpful suggestions.

Although I had anticipated when I started the project that it might take a number of years to complete, I never would have imagined that it would take longer for me to write up the results than to do the analysis. Thanks for being patient.

[Contents](#)

*previous:* [Analyses](#) *next:* [Overview of Analyses](#)

[Home](#)

[Six Piece Burrs](#)

[Box-Filling Puzzles](#)

[Booklets](#)

[About our Puzzles](#)

[Rectilinear Burrs](#)

[Miscellaneous Puzzles](#)

[References](#)

[How to Order](#)

[Non-Rectilinear Burrs](#)

[Computer Programs](#)

[Other Websites](#)

Copyright 2000-2002 Bill Cutler Puzzles, Inc.

# Overview of Analyses



billcutlerpuzzles.com

[Contents](#)

*previous:* [Acknowledgements](#) *next:* [The Pieces](#)

## Introduction

The analysis presented in this booklet is the natural culmination of several previous analyses of 6-piece burrs. It also combines two different interests of mine: computer programming and burrs.

When I was 12 years old, I saw a model of a 6-piece burr in a drugstore window, and became fascinated with it. Like many people before me, I attempted to catalog solid 6-piece burrs which used notchable or more limited sets of pieces, but gave up at the enormity of the project. After reading E.M. Wyatt's books "Puzzles in Wood" and "Wonders in Wood" [8] & [9], I started to design my own burrs. I was particularly intrigued with designing burrs which took many moves to remove the first piece. These designs typically had at least 18 pieces. The size of the 6-piece burr did not allow for implementing most of the "tricks" that I used in the designs.

In college I was exposed to computers, and became fascinated by the possibility of using computers to solve mechanical puzzles, in particular "box-packing" puzzles. However, I could only pursue this interest in theory because of the limited availability of computers.

## Solid Analyses

In 1974 my interest in computers was rekindled, and I wrote the first programs to analyze 6-piece burrs. These programs did little more than count solid solutions. They included some rudimentary logic to check for symmetry so that rotations & reflections would be properly identified. The code used to throw out assemblies which did not come apart was specifically tailored for solid, 6-piece burrs; all it did was implement specific rules which had been developed by hand. The analysis of solid, notchable 6-piece burrs was done jointly with Tom O'Beirne and was published in the Journal of Recreational Mathematics [3] and is referred to as JRM in this booklet. A later analysis of all solid 6-piece burrs was done with the assistance of Arthur Cross. The results of this study were made available as a 1-inch stack of computer output [4] and was referenced in Martin Gardner's column in Scientific American [7]. Arthur Cross also wrote up the results in a booklet [2]. We will refer to this analysis as SCIAM.

## Computers & Burr-Disassembly Programs

In the early 1980's, two events triggered an expanded analysis of 6-piece burrs:

1. Following conversations with David Bruce, I was motivated to write a computer program which could disassemble interlocking puzzles made from cubes.
2. Stewart Coffin, who had been toying with "holey" 6-piece burr designs, challenged his readers to design their own 6-piece burrs and offered to manufacture the design that he chose as best.

The result was BURR6, a powerful program for analyzing 6-piece burrs, and Bill's Baffling Burr. BBB is an

example of a "computer-assisted design". The sequence of moves used to take out the first piece was chosen by hand along with an initial set of piece shapes to carry this out. The computer program was used to verify the take-apart steps and to search for alternate solutions using the same pieces ("uniqueness" check). Nine variations of the pieces were analyzed by the programs, and one of these which had a unique solution was chosen as Bill's Baffling Burr.

Thus began the investigation into "holey" 6-piece burrs. From the beginning, it has been required that all "holes" in a 6-piece burr are not visible from the outside when the burr is in its assembled state, and therefore are limited to the 32 internal cubes of [Figure 2](#). After the initial success of Bill's Baffling Burr, I ran programs which analyzed thousands of assemblies constructed from limited piece sets looking for high-level solutions. The results were disappointing - the highest level discovered was only 4.

In June of 1986 I purchased an 8MHZ IBM PC AT for the express purpose of running puzzle analysis programs. The personal computer made available much more computer time to me than was previously possible. Although large, "mainframe" computers still ran about 40 times as fast as the AT, the PC could be run 24 hours a day, which equated to considerably more time than could be commandeered by an ordinary programmer on his work machine. In addition, puzzle problems are mostly combinatorial in nature, so deal with small integers rather than single or double-precision floating point numbers used by most "number-crunching" programs. Such combinatorial problems are ideally suited for running on PC's.

## **NOTC - Notchable, Holey Analysis**

I continued to fine-tune the performance of the programs and in the spring and summer of 1987, I ran a complete analysis of all notchable, holey 6-piece burrs. I found many high-level burrs, including two level-10 assemblies. Unfortunately, the highest level for unique solutions in the notchable case was only 5. The method used to construct the notchable assemblies is described in Chapter III, except that the pieces were restricted to notchable ones.

## **HB6 - General, Holey Analysis**

I then looked into the possibility of analyzing all 6-piece burr assemblies. My original estimate for computer time needed to do this analysis on my computer was 400 years. Obviously, I was going to need some help! I started with the low-hole assemblies, because I was mainly interested in unique solutions. Unique solutions are much more likely to occur when there are few holes, and low-hole assemblies had the additional advantage that they could be analyzed more quickly.

These first programs were run on 0, 1, 2 and 3-hole assemblies, and were called GB6 programs. The assembly-construction logic for these programs was more complicated than that used in the NOTC analysis.

Two things happened to speed up the project immensely:

1. Harry Nelson, who had access to a number of Cray computers at Lawrence Livermore Labs, offered his services. He was able to run the programs on these machines when they had nothing better to do.
2. The introduction of the 80386 chip and the proliferation of PC's with these chips gave me access to much more power through work and puzzle friends.

After the runs were completed on the 0-3 hole assemblies, and the 4 and 5-hole analyses were well under

way, the HB6 programs were written to analyze assemblies with from 6 to 15 holes. These programs were not used to analyze assemblies with 16-20 holes because there are so few of these assemblies, and allowing for these would increase the size of the program and datasets. The high hole assemblies were run in a short time using a different set of programs called IB6.

The assembly-construction logic from the HB6 programs was used to COUNT all assemblies. These results were later used to check the validity of the counts from the NOTC, GB6 and IB6 programs. These counts were also used to make a better prediction of the computer time needed to complete the analysis. The new time estimate was reduced to 62.5 years on one PC AT, due mainly to the fact that notchable assemblies are likely to have more holes than un-notchable assemblies.

The result was that it took only two and one-half years to complete the analysis of all 35.5 billion 6-piece burr assemblies.

The tables in the Appendix give examples and summary results of the analysis. [Tables 9](#), [13](#) and [14](#) were used to keep track of the status of the project as it progressed.

## Computer Usage and the Four-Color Problem Analysis

The amount of computer time used in the project was enormous.

The unit of computer time used throughout the analysis and in the tables in this booklet is the 'AT-hour', or 1 hour on an 8 MHZ IBM PC AT. Although only a small part of the analysis was run on this machine (and similar machines have been obsolete for years), it was convenient to keep this unit of measure for the duration of the project. The table below is a rough comparison of the speeds of several old and current machines. Some of the numbers are more accurate than others - comparisons of PC's were easily made by running identical programs; PC - mainframe/workstation comparisons were made running comparable FORTRAN programs; and the factor for the IBM 360 mainframes is a guess. The numbers are supposed to represent a comparison when running combinatorial (or small integer) problems. Floating point power ('math co-processor' chips on PC's) is unused. The numbers assume a comparable level of programming efficiency on each machine (optimized FORTRAN on both, or assembly-language on both, written for performance).

Computer/Maker	Chip/Speed	Year	Speed Factor	Time for HB6 Complete Run
IBM PC AT	8MHZ 80286	1986	1.0	62.5 years
IBM PC	8086	1984	0.25	250 years
IBM PC w. Intel	16MHZ 80386	1988	3.0	21 years
Gateway 2000	33MHZ 80486	1992	14.0	4.5 years
IBM 3083 mainframe		1988	40.0	1.5 years
IBM 3090-600E - single processor		1993	85.0	9 months
IBM 3090-600E - all six processors		1993	500.0	6.5 weeks
IBM 360 mainframe		1975	6.0	10 years
IBM RS6000 workstation - model 250T		1993	200.	4 months

By comparison, the best-known (and earliest) use of computers for solving mathematical problems was the proof of the Four-Color Map Theorem completed by Kenneth Appel and Wolfgang Haken at the University of Illinois in 1978 [1]. They used a total of about 2,000 hours of computer time on 3 IBM 360 mainframe machines. Using the factor of 6 above, this is equivalent to about 1.4 AT-years, so the HB6 project took about 45 times as much computer power to complete.

I am currently the System Administrator for a network of 8 RS6000 workstations at CR Industries. These machines are left running at all times. If I scheduled the HB6 programs to run on these machines at a low priority, the project would be completed in a little over 2 weeks. Within a year, the number of workstations is expected to climb to over 30, and the runtime would reduce to 4 days!

## Availability of Computer Results

The amount of data generated by the computer runs was considerable. The main summary of the results counted the assemblies by:

1. Notchable or General
2. Number of Holes
3. Level-Type
4. Symmetry Type

[Tables 4](#), [5](#), and [6](#) in the Appendix give sub-totals of this larger table, but the entire table is too large to include in this booklet. The table is available on computer diskette and is called SUMDSN.txt.

About 70,000 high-level solutions were saved. These are available in either LL Format (4 diskettes) or AF Format (10 diskettes).

If you are interested in obtaining any of the computer results on diskette, write to Bill Cutler Puzzles, Inc., 405 Balsam Lane, Palatine, IL 60067 for more information.

[Contents](#)

*previous:* [Acknowledgements](#) *next:* [The Pieces](#)

<a href="#">Home</a>	<a href="#">Six Piece Burrs</a>	<a href="#">Box-Filling Puzzles</a>	<a href="#">Booklets</a>
<a href="#">About our Puzzles</a>	<a href="#">Rectilinear Burrs</a>	<a href="#">Miscellaneous Puzzles</a>	<a href="#">References</a>
<a href="#">How to Order</a>	<a href="#">Non-Rectilinear Burrs</a>	<a href="#">Computer Programs</a>	<a href="#">Other Websites</a>

Copyright 2000-2002 Bill Cutler Puzzles, Inc.



# The Pieces



billcutlerpuzzles.com

[Contents](#)

previous: [Overview of Analyses](#) next: [Constructing Assemblies](#)

The pieces which can be used in making standard 6-piece burrs are constructed by removing some of the 12 cubes from the piece in Figure 1 (below). Of the  $2^{12} = 4096$  ways to remove the 12 cubes, 1871 result in disconnected pieces, leaving 2225 different connected configurations. These 2225 combinations are produced by 837 distinct physical pieces. 59 of these pieces are notchable, and they relate to 147 of the 2225 cube combinations.

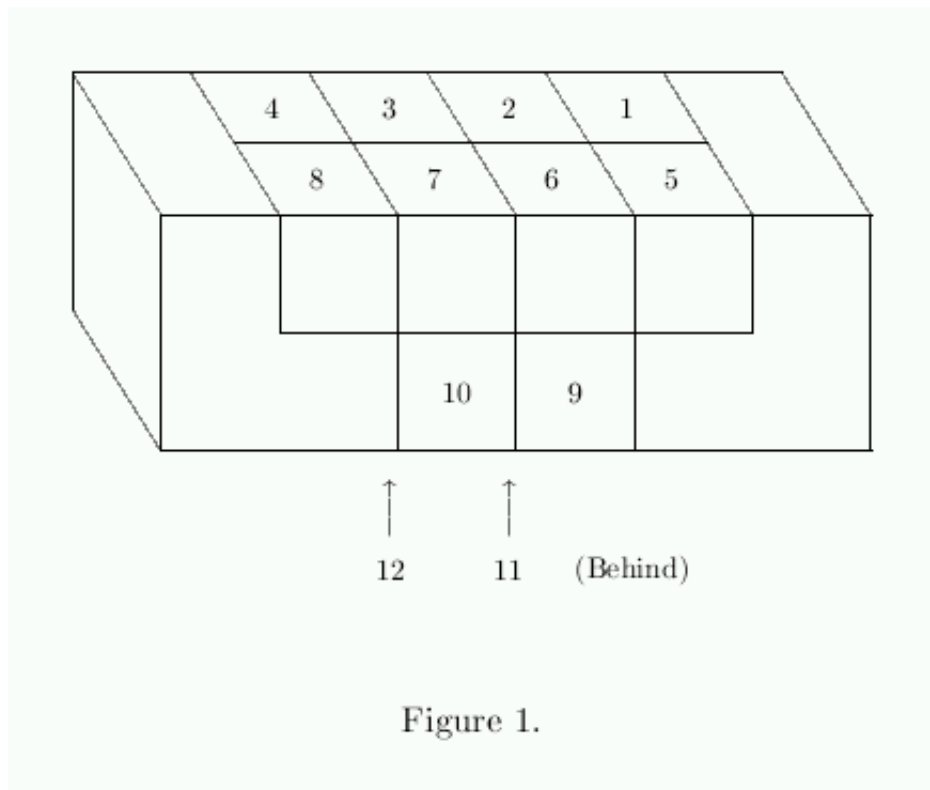


Figure 1.

When we refer to "pieces" or "physical pieces", we will be referring to one of the 837 pieces. The 2225 cube combinations will be referred to as "piece orientations".

The 59 notchable pieces are pictured in [Figure 3](#). The first 25 pieces in the list correspond to the 25 pieces in JRM. The remaining 34 pieces cannot be used in notchable, solid solutions; but they can be used in general, solid solutions, so are used in the SCIAM analysis.

The 837 pieces are listed in [Table 2](#).

The 2225 piece orientations are listed in [Table 3](#).

## Ambiguous Pieces

Ambiguous pieces are ones which can be rotated about the long axis without creating external holes. These pieces must have either cubes 1&4 or 5&8 filled in [Figure 1](#).

Examples: pieces #27 (cube codes: 1011 1011 11 11) and #228 (cube codes: 1011 0001 01 11) are ambiguous.

Piece #696 (cube codes: 1001 0000 00 11) might be called 'pseudo-ambiguous'. It can be rotated to form a new configuration, but it can also be flipped end-for-end to achieve the same configuration without using its 'ambiguity'.

## Methods for Piece Construction

Let us briefly consider how to manufacture un-notchable pieces made out of wood. One can either chisel out the un-notchable areas, or glue cubes back into the piece. The glue-in method is easier, but the glue joints may be visible from the outside of the assembled puzzle. For many un-notchable pieces, it is a simple matter to glue cubes on the part of the piece which will be inside the assembled burr. For un-notchable, ambiguous pieces, it may be impossible to glue the cubes in so that they are invisible for all assemblies using the piece, but one can choose the gluings to be invisible for the desired solution to the puzzle. This will give a clue to the solution, but this cannot be helped for some burrs when using the glue-in method.

Now we can consider one particularly unusual piece:

Piece # 616 (cube codes: 0000 1001 00 11)

This piece appears in many high-level solutions discovered by the computer, including Computer's Choice Unique-10. The easiest way to make it is by gluing in cubes # 4 and 8. However, in the high-level solutions, the piece appears in one of its ambiguous rotations, either 1111 0000 00 00 or 0000 1111 00 00. There is no easy way to construct the piece so that the glue joints are on the inside when oriented this way. Jerry McFarland makes this piece in the following way:

1. Notch out cubes 1-8
2. Glue in a 4-cube length rod in positions 1-4, and let dry
3. Notch out cubes 9-12.

The result is a piece which appears to be glued from 3 separate parts, and has the glue joints on the inside when used in Computer's Choice Unique-10.

[Contents](#)

*previous:* [Overview of Analyses](#) *next:* [Constructing Assemblies](#)

[Home](#)

[Six Piece Burrs](#)

[Box-Filling Puzzles](#)

[Booklets](#)

[About our Puzzles](#)

[Rectilinear Burrs](#)

[Miscellaneous Puzzles](#)

[References](#)

[How to Order](#)

[Non-Rectilinear Burrs](#)

[Computer Programs](#)

[Other Websites](#)

Copyright 2000-2002 Bill Cutler Puzzles, Inc.

# Constructing Assemblies



billcutlerpuzzles.com

[Contents](#)

previous: [The Pieces](#) next: [Analyzing Assemblies](#)

## Symmetry of Assemblies

The outside of the 6-piece burr has considerable symmetry. There are 23 different ways to rotate and/or reflect the shape which end up looking the same. To these 23 symmetries add the 'identity' symmetry, which does not move the object at all, and the result is a mathematical group of order 24.

When a 6-piece burr assembly is analyzed, one can ask whether the internal cube arrangements have any symmetry. There are 11 possible answers to this question, which are listed below. The syntax of the symmetry designations should become clear.

### Possible symmetries:

- 1** no symmetry of assembly
- 2MA** reflective symmetry through some plane
- 2MB** reflective symmetry through the center of the burr
- 2R** 180-degree rotational symmetry about some axis
- 3R** 3-way rotational symmetry which interchanges the axes
- 4MA** 4-fold symmetry including 2 reflective symmetries through different planes and 1 180-degree rotational symmetry.
- 4MB** 4-fold symmetry including 1 reflective symmetry through a plane, 1 180-degree rotational symmetry, and reflective symmetry through the center.
- 4R** 180-degree rotational symmetry about all 3 axes
- 6M** 3-way rotational symmetry and reflective symmetry through the center, giving 6 symmetries.
- 8M** reflective symmetry through each orthogonal plane, resulting in 8 symmetries total, 4 of which are reflective.
- 24M** all symmetries. This is possessed by only one assembly, which is constructed from 6 piece #2's (JRM numbers). This assembly has 8 internal cube voids in the center and cannot be taken apart.

For those interested in the mathematics, these symmetry types represent all subgroups of the order-24 group of external symmetries except the subgroup which would be designated as 12R. Using the standard cubic-cut pieces, the only assembly with these symmetries is the assembly which has symmetry type 24M.

Examples of assemblies with each of these symmetry types are in the Appendix in [Table 6](#).

## Choice of Construction Method

There are two options for constructing all the 6-piece burr assemblies with a computer program:

1. Have the program determine all different sets of 6 physical pieces (including duplicates), and for each of these determine all possible assemblies that can be constructed from them. Then analyze each of these assemblies to see if it is a solution, and how interesting it is.
2. Have the program construct the assemblies individually, analyzing each one after it has been constructed.

The advantage to 1) is that the uniqueness of solutions will be immediately known, as all other assemblies using the same pieces will be done at the same time.

The advantage to 2) is that the program logic for constructing assemblies will be executed essentially once, rather than being re-executed for each new set of pieces.

Approach 2) was chosen because of the huge savings in computer time for constructing the assemblies. This then required that all "interesting" assemblies be reexamined to check for uniqueness.

## The Basic Logic

The goal of the program logic is to do the following:

1. Determine all possible ways in which the 32 cubes in the interior of a 6-piece burr can be assigned to one of the 6 pieces, or to empty space, so that all 6 pieces are connected pieces formed by removing cubes from [Figure 1](#).
2. Rotations and/or reflections of the internal cube construction should not be duplicated - that is, of the 24 possible rotations and reflections, one should be recognized as the "first" one, which is analyzed; and all the others should be recognized as not being the "first", and so should be discarded.
3. If some of the 24 rotations/reflections are the same as the original, record this information so that assemblies can be counted by symmetry type.

This section describes how the above requirements were carried out. The logic was used for the NOTC and HB6 analysis programs. The early general, holey programs, called GB6, which were used to analyze 1, 2, 3, 4 and 5-hole assemblies used a more complicated logic which will not be described here.

The first task is to order the 2225 piece orientations. The following operations can be applied to each piece orientation:

- Side-to-side reflection (SIDM)
- End-for-end rotation (FLIP)
- End-for-end reflection (EFEM)

These operations correspond to cube switchings as follows (numbers as in [Figure 1](#)):

- SIDM: 1-5, 2-6, 3-7, 4-8, 9-11, 10-12.
- FLIP: 1-8, 2-7, 3-6, 4-5, 9-12, 10-11.
- EFEM: 1-4, 2-3, 5-8, 6-7, 9-10, 11-12.

When rotating or reflecting an assembly, each piece orientation may change. The 3 permutations above, plus the original orientation, are the only ways a piece orientation may be changed when an assembly is rotated and/or reflected. Rotations about the long axis for ambiguous pieces cannot occur during R&R of an assembly.

Each of the 2225 piece orientations is grouped with the 3 (or fewer) piece orientations resulting from applying SIDM, FLIP, and EFEM. The result is as follows:

- 534 groups of 4 piece orientations
- 42 groups of 2 piece orientations
- 5 groups of 1 piece orientation.

Each group is represented by the piece orientation of the group which has the smallest MATR. MATR is computed with the following formula:

$$\text{MATR} = 4096 - X(1) - 2*X(2) - 4*X(3) \dots - 2048*X(12)$$

where  $X(i) = 1$  if cube #i ([Figure 1](#)) is present, and  
 $0$  if cube #i is missing.

For example, the solid piece has piece orientation number:

$$\text{MATR} = 4096 - 1 - 2 - 4 - \dots - 2048 = 1$$

and the piece which has 10 cubes cut out (number 3 in the JRM notchable list) has two piece orientations with MATR values 1024 and 3328.

The sorting of the 2225 piece orientations is done as follows:

1. The solid piece is placed first
2. The groups of 4 are placed next, so that the group representative has an order number of the form  $2 + 4*N$ , and the remaining members of the group have the next 3 positions in the order SIDM, FLIP and EFEM. Those groups whose pieces have the fewest removed cubes come first, and within groups where this number is the same, the group containing the lowest MATR number comes first. The sort numbers for these groups are from 2-2137.
3. Next are placed the groups of 2 piece orientations each, with the same rules as 2) for sorting these groups with each other. These sort numbers are from 2138-2221.
4. Finally, the remaining 4 piece orientations which are in groups by themselves are placed in positions 2222-2225.

A listing of the 2225 piece orientations in this order is in [Table 3](#).

## The 534 Cases

The vast majority of the assemblies can now be constructed in 534 different groups as follows:

1. Let N be a number from 1 to 534.
2. In piece position 1 from [Figure 2](#) place the representative of the Nth group of 4 piece orientations. The sort order for this piece orientation will be  $2 + 4*(N-1)$ .

- Construct all assemblies in which the other 5 pieces are occupied by piece orientations with numbers from  $2 + 4*N$  to 2225. This is easily done with a computer program with 5 nested loops, with the loop indices taking all values from  $2+4*N$  to 2225. Each time a loop index is changed, the piece orientation specified by the loop value is checked to see if it can fit with the pieces already placed. If there is interference with another piece, the next value is tried without executing the inner loops. The program places pieces in [Figure 2](#) in the order 1-3-5-2-4-6. This is so that as much interference as possible occurs early on to save loop overhead.

It is easy to see that all assemblies constructed by this procedure have no internal symmetry, and that no 2 such assemblies are equivalent to each other by rotation and/or reflection. In addition, the only assemblies which are not constructed by this method are those in which either:

- One piece is solid
- None of the 6 piece orientations belongs to one of the 534 groups of 4, or
- Two or more of the 6 piece orientations belong to the same group of 4, and the others belong to groups higher in the sort order.

[Table 9](#) contains information on each of these cases and who ran the program for this case.

## The Remaining Cases

Eight more specialized programs were written and run to handle the small number of assemblies not handled by the 534 cases. These results are summarized as cases 535-542. The eight cases are listed below:

- One solid piece. The solid piece ( $MATR = 1$ ) is assigned to piece #1 in [Figure 2](#). The other pieces may take on any of the other piece orientations, but comparisons of pieces 3 & 4 and pieces 5 & 6 are made so two assemblies which are rotations or reflections of each other are not both analyzed. Some assemblies have symmetry of order 2 or 4, and these are counted separately. No disassembly analysis is run as all these assemblies have a partial solution of level-1. The results are recorded as case #535.
- Two pieces are from the same group-of-4 and the other four pieces have higher sort numbers. In addition, these two pieces are not parallel in the assembly. This is handled as follows: For each N from 1 to 534, piece #1 in [Figure 2](#) is assigned number  $2+4*(N-1)$  and piece #3 is allowed to have all values from the group, that is  $2+4*(N-1)$  through  $5+4*(N-1)$ . The other four pieces may take on any values greater than  $5+4*(N-1)$ . The program is then also run with piece #1 given value  $4+4*(N-1)$ . All the resulting assemblies are different and have no symmetry. The results are stored as case #536.
- Two pieces are from the same group-of-4 and the other four pieces have higher sort numbers. In addition, these two pieces are parallel and have the same piece orientation number. The program handles this by assigning  $2+4*(N-1)$  to both piece #1 and piece #2. About half of the assemblies are skipped, and a small number have rotational symmetry about the long axis of pieces 1 and 2. The results are stored as case #537.
- Same as 3), except that piece #2 is assigned number  $3+4*(N-1)$ , or SIDM of piece #1. Some of the assemblies have reflective symmetry through the plane between pieces 1 & 2. The results are stored as case #538.
- Same as 3), except that piece #2 is assigned number  $4+4*(N-1)$ , or FLIP of piece #1. Some of the assemblies have rotational symmetry about a third axis. The results are stored as case #539.
- Same as 3), except that piece #2 is assigned number  $5+4*(N-1)$ , or EFEM of piece #1. Some of the assemblies have reflective symmetry about the center. The results are stored as case #540.

7. Three or more pieces are from the same group-of-4 and the other pieces (if any) have higher sort numbers. The program has elaborate symmetry-checking code to eliminate assemblies which are R&R equivalent to previously analyzed assemblies. The assemblies can have a variety of symmetries which are recorded separately by the program. The results are stored as case #541.
8. No piece is from a group-of-4, and no piece is solid. All pieces have sort orders 2138 or higher. This program also includes elaborate symmetry checking and recording. The results are stored as case #542.

[Contents](#)

*previous:* [The Pieces](#) *next:* [Analyzing Assemblies](#)

[Home](#)[Six Piece Burrs](#)[Box-Filling Puzzles](#)[Booklets](#)[About our Puzzles](#)[Rectilinear Burrs](#)[Miscellaneous Puzzles](#)[References](#)[How to Order](#)[Non-Rectilinear Burrs](#)[Computer Programs](#)[Other Websites](#)

Copyright 2000-2002 Bill Cutler Puzzles, Inc.

# Analyzing Assemblies



billcutlerpuzzles.com

[Contents](#)

*previous:* [Constructing Assemblies](#) *next:* [Uniqueness and Disassembly](#)

## The GENDA Program

The analysis presented in this booklet would not have been possible without the development of a computer program to analyze the disassembly of puzzles made of pieces "built-up" from cubes. Pieces in the puzzle are allowed to move only in one of the three orthogonal directions, and the distances they move must be a multiple of the cube width. They may not be twisted or moved a fraction of a cube width. Pieces may either move individually or in groups. The first such program to be written is called GENDA (GENERAL DisAssembly); it was written in FORTRAN and has the most sophisticated logic of any of the programs used in the 6-piece burr analysis.

The following is an outline of the procedure used by the program for doing disassembly analysis:

1. The program starts with the assembled puzzle. If the program is successful in completely disassembling the puzzle, then the results can be used 'backwards' to assemble the puzzle from its separate pieces. An assembled puzzle is a 3-dimensional grid of cubes in which each cube is part of a particular piece or is empty space. If there are  $N$  pieces in the puzzle, this is represented in the computer by a 3-dimensional array containing integers from 0 to  $N$ . The value of a particular array element indicates the piece number that occupies the corresponding cube, or 0 if the cube is empty.
2. The allowable movements in the physical puzzle correspond to simple changes in the values of the array.
3. During movement prior to disassembly, the puzzle will pass through different 'states'. Each state is a different arrangement of the pieces in the same grid of cubes. Within the computer program, a state is represented by the amounts that each of the pieces have been moved in each of the three directions from their starting position. If one fixes piece #1 in its initial location, then each state is uniquely represented by the offsets of the other  $N-1$  pieces, or  $3 \times (N-1)$  integers.
4. The problem can thus be reduced to analyzing movement in a single direction and determining which states can be reached from another state by movement in this direction. The program must be able to identify when one or more pieces may be separated from the rest of the pieces by movement in a single direction. This is called a partial solution, as the remaining groups of pieces may still not come completely apart. Movement in a single direction will be described in more depth in the next section.
5. The logic for completely disassembling a puzzle is just repeated applications of the same logic for disassembling the whole puzzle. Each time a group of pieces is disassembled, the resulting sets of pieces are cataloged as sub-assemblies. Any sub-assembly with more than one piece is saved for later analysis.

The key to the analysis is keeping track of the states:

1. At the beginning of the analysis, the list contains only one state: the starting position, in which the offsets of all the pieces are 0.
2. Pick the next unanalyzed state in the list, and choose one of the orthogonal directions. Determine how



much movement of the pieces relative to each other in this direction is possible. Use this information to construct all states which can be reached from the original state with one move. If the movement allows for complete separation of two or more sets of pieces, then we have found a partial solution and can stop.

3. For each of these new states, determine if it has already been recorded in the list of states. This is easily done by comparing the offsets of the pieces of the new state with the offsets of the pieces in each state in the list. (Recall that Piece #1 is not allowed to move - its displacements are always 0). If it has not previously been recorded, add it to the list; otherwise, discard it.
4. Continue with the analysis until either:
  - o Some state leads to disassembly in one move *or*
  - o The state list has been completely analyzed; no new other states can be reached from any of the states in the list.
5. Since there are only a finite number of states in which all the pieces are still interlocked, the process must end at some time. For some burrs with many pieces and independent movement of parallel pieces (ex. Van der Poel's 18-piece burr), this may involve hundreds of states and may take a significant amount of computer time; but the process is still finite.

## Analyzing Movement in One Direction

This section is more technical than the rest of the booklet. It is included because it contains the single most interesting piece of logic or mathematics used by the programs.

### How is movement in one direction analyzed?

Let  $N$  be the number of pieces in the puzzle.

Let  $GRID(x,y,z)$  be the array containing the piece numbers which occupy each cube, and assume that the dimensions of  $GRID$  are less than 100 in each direction. We will analyze movement in the first orthogonal direction, that is the first superscript ( $x$ ) of  $GRID$ .

We will construct an  $N$  by  $N$  matrix,  $MOVE(i,j)$ , which will show how each pair of pieces may move in relation to each other in the fixed direction.  $MOVE(i,j)$  is a non-negative integer which is the number of cubic widths piece #  $i$  can be moved in the positive direction while keeping piece #  $j$  fixed. If there is no limit to how far piece #  $i$  can be moved in this direction without moving piece #  $j$ , then this value is set to 100.

The following steps are used to construct the matrix  $MOVE$ :

1. Initialize the main diagonal of  $MOVE$  to 0 and all other entries to 100.
2. Determine simple piece interactions (compute values for  $MOVE(i,j)$  by ignoring pieces except for  $i$  and  $j$ ) as follows:

```

For each i from 1 to N;
  For each j from 1 to N except j=i;
    For each (x1,y1,z1) for which GRID(x1,y1,z1)=i;
      For each (x2,y2,z2) for which GRID(x2,y2,z2)=j;
        If y2=y1 and z2=z1 and x2>x1, then
          let k=x2-x1-1; if MOVE(i,j) > k, then MOVE(i,j)=k.
  
```

(The actually programming of the above step can be done more efficiently, but it is easier to explain this way).

3. Introduce interactions of other pieces. It is geometrically evident that the final MOVE matrix must satisfy the following transitive relationship:

For all pieces  $i, j, k$ ,

$$\text{MOVE}(i, j) \leq \text{MOVE}(i, k) + \text{MOVE}(k, j)$$

What is not so immediately apparent is that this is the only additional change that must be made to get the desired result.

Loop through all values of  $i, j, k$  and compare  $\text{MOVE}(i, j)$  with  $\text{MOVE}(i, j) + \text{MOVE}(j, k)$

If  $\text{MOVE}(i, j)$  is larger, replace it with the value on the right.

Continue doing this over and over until no further changes are required for any values of  $i, j, k$ .

If any  $\text{MOVE}(i, j) = 100$ , a partial solution has been found.  
 If all values of MOVE are 0, then there is no movement.  
 Otherwise, there is some movement in the chosen direction.

## The FDA Program

When the project to analyze all 6-piece burr assemblies was started, it was clear that a faster, more efficient program would be needed in order to have any hope of completing the project in a reasonable time. To this end, the following modifications were made to the GENDA program:

1. Only do partial disassembly analysis. In other words, only determine the first separation of the pieces and how many moves it took to achieve this. Assemblies which took a lot of moves for the first disassembly would be saved for a later, more thorough, analysis. Since the goal of the program was to find 6-piece burrs which took as many moves as possible to remove the first piece, all candidates for this honor would be identified.
2. Rewrite all routines with a fixed number of 6 pieces, and take advantage of this where possible to make the code more efficient.
3. Rewrite the most time-consuming routines in 8086 Assembler (PC machine language) to get the most speed possible.

An additional complication was also added to the routines - varying piece lengths. Early on, it was realized that a thorough investigation of 6-piece burr assemblies must be sensitive to the lengths of the pieces. Lengths of 6, 8, 10 and 12 may produce different results, although it is rare for there to be a difference between lengths 10 and 12. Even though the original intention of the analysis was only to identify high-level solutions, no short cuts on piece length are possible - an assembly which is level-8 with length 10 pieces may be only level-3 with length 6 pieces; and, conversely, an assembly which is level-8 with length 6 pieces may have no solution with length 8 pieces.

The result was a new program for 6-piece burr analysis called FDA (Fast Disassembly Analysis). For each

assembly analyzed, the resulting output is a group of 4 numbers called the 'level-type'. These are the number of moves required for the first disassembly with length 6, 8, 10 and 12 pieces.

The FDA routines handle the multiple length analysis as follows:

1. Movement of the initial position is analyzed - this movement is independent of piece length. If no movement is found, then the level type is 0-0-0-0. If a level-1 solution is found, then the level-type is 1-1-1-1.
2. If there is movement, but no level-1 solution, save all states created.
3. Continue the analysis with length 6 pieces. During the analysis, each movement and resulting state is analyzed as to whether it can be "generalized" using unlimited length pieces. If a solution is found, and all movements leading to the solution can generalize, then the assembly has the same level solution for all longer pieces also. If no solution is found, then there is no solution with longer pieces either.
4. If a length-6 solution is found which does not generalize, then redo the analysis with length 8 pieces, again checking for generalization possibilities.
5. Repeat with length 10 and 12 pieces if necessary.
6. Save the solution level found at each length.

Note: Level-type 0-0-0-1 is used to indicate that there is movement in the assembly, but no solution at any length.

After the FDA analysis for an assembly is completed, the program does the following:

1. Record the results by level-type, number of holes, whether notchable or general, and any symmetry of the assembly.
2. If the assembly is deemed to be 'special', write out the assembly to a separate file so that it can be analyzed in more detail later. An assembly was deemed to be 'special' if either:
  - o The level of solution with some length of pieces was 8 or more
  - o The level-type was a new combination not seen before.

The format used to print out 'special' assemblies is called the "LL Format".

## D. The LL Format

The following are LL listings for 3 assemblies:

LL-Format	E	H	S	6	8	A	C	Name
35350030443000251130143320220666	0	9	0	12	0	0	0	Love's Dozen
5555530043022551131642000220636	0	7	0	5	0	0	0	Bill's Baffling Burr
05550110503004001116603664226666	0	9	0	4	6	10	10	L46AA Notchable

The most important information is the first 32 numbers under the heading "LL-Format". These represent the internal cube arrangements of the assembly. Compare these numbers with Figure 2 (below). Each of the 32 numbers represents the allocation of one of the unassigned cubes in Figure 2. A '0' in the listing indicates that the cube is empty. A number from 1-6 indicates the number of the piece to which the cube belongs.

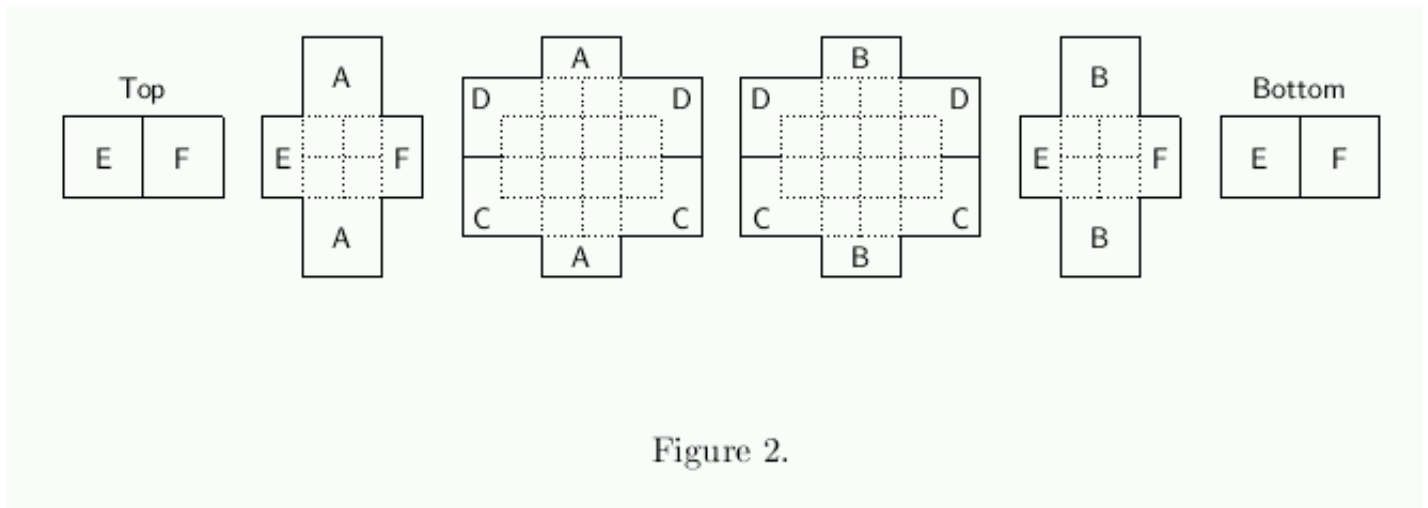


Figure 2.

The additional entries in the LL listing are less important, and can be recomputed if necessary:

- The 'E' column is an error return which was used during the program run to indicate non-critical problems which occurred when that assembly was run, such as too much movement within the assembly or a new level-type.
- The 'H' column is the number of holes in the assembly (same as the number of 0's in the LL-format).
- The 'S' column was used for an analysis variable which will not be discussed here.
- The '6', '8', 'A' and 'C' columns give the levels at lengths 6, 8, 10 and 12, respectively. Together, these 4 numbers are the level-type.

See Love's Dozen or Computer's Choice Unique-10 in the examples for demonstrations of the use of the LL-Format.

[Love's Dozen LL Format to Assembly](#)

[Computer's Choice Unique 10 LL Format to Assembly](#)

[Contents](#)

*previous:* [Constructing Assemblies](#) *next:* [Uniqueness and Disassembly](#)

Home

Six Piece Burrs

Box-Filling Puzzles

Booklets

About our Puzzles

Rectilinear Burrs

Miscellaneous Puzzles

References

How to Order

Non-Rectilinear Burrs

Computer Programs

Other Websites

Copyright 2000-2002 Bill Cutler Puzzles, Inc.

# Uniqueness and Disassembly



billcutlerpuzzles.com

[Contents](#)

*previous:* [Analyzing Assemblies](#) *next:* [Take-Apart Methods](#)

## Analysis of Interesting Assemblies

All assemblies which had a partial solution of level-8 or higher were saved for later, more thorough analysis. Three different programs were run on each assembly:

1. Complete disassembly analysis
  1. Can disassembly be completed, or is it only a partial solution?
  2. How many states did the program analyze before finding the solution?
  3. Describe the movements used to remove the first piece
2. Analysis of other assemblies made with the same pieces
  1. How many other assemblies can be made?
  2. How many other assemblies have solutions, or does the original assembly have a unique solution?
  3. What are the highest and lowest levels of other solutions?
3. Analysis of pieces used in the assembly
  1. How many notchable pieces?
  2. How many ambiguous pieces?
  3. Any duplicate pieces?

The results of these analyses are summarized in a file referred to as an 'AF Format' file.

## Apart-Codes

The goal of the analysis programs was to find different, high-level methods for disassembling 6-piece burrs. In most assemblies, minor changes can be made to the internal cube arrangements which do not change the way in which the first piece is removed. Usually there are large groups of assemblies which come apart in virtually identical fashions. A shorthand notation for the disassembly method was developed so that comparisons could easily be made between different assemblies to see if they functioned in the same fashion. This shorthand notation is called the "Apart-Code".

For example, the L5 Notchable puzzle has a level-5 solution. The LL format of the assembly found by the program was:

```
55551133140220226630440060666606 0 7 2 5 0 0 0
```

The Apart-Code for this solution is:

```
3146 1124 316 11246
```

This code details the first 4 moves of the disassembly. During the 5th move, the pieces come apart, and this move is not included. The interpretation is as follows:

Move1	Move2	Move3	Move4
xuppp	xuppp	xuppp	xuppp
3146	1124	316	11246

Each move is represented by from 3 to 5 characters. The first character ('x') denotes the direction of the move: either 1, 2 or 3. The second character ('u') denotes the number of units that the pieces move in this direction: 1,2,3 for movements in the positive direction and F,E,D, respectively, for 1,2,3 units in the negative direction. Finally, the 3rd and subsequent characters ('ppp') denote the piece numbers which are moved. (up to 3 pieces can be moved at once).

Thus, the moves represented by the above apart-code are:

Move1: In direction #3, move pieces 4 & 6 +1 unit  
 Move2: In direction #1, move pieces 2 & 4 +1 unit  
 Move3: In direction #3, move piece 6 +1 unit  
 Move4: In direction #1, move pieces 2, 4 & 6 +1 unit

Many assemblies have more than one way to arrive at the first disassembly in the same number of moves. This is true of the L5 Notchable puzzle as well. It has 4 different ways to make the first 4 moves, after which a disassembly is possible in one move. The Apart-Codes for these movements are:

3146	1124	316	11246
3146	1124	316	1F13
3146	11245	316	11246
3146	11245	316	1F13

It was necessary to choose one of these as the 'standard' solution. Rules were made to decide between any two moves, or a group of moves, as to which was the 'standard' move. Generally speaking, the rules are:

1. Move as few pieces as possible on any one move
2. Move the shortest distance
3. Move in the positive direction, rather than the negative
4. Move in direction #1 rather than direction #2 or #3, and move in direction #2 rather than direction #3
5. Move lower-numbered pieces rather than higher-number pieces

When the rules are applied to choose one solution from a group of 2 or more, the move(s) which differ between the solutions are marked at the end with a '\*'. The 'standard' solution from the above four solutions is:

3146    1124 \*    316    1F13 \*

There remains one other significant problem to resolve. Each assembly has 24 rotations and/or reflections which are usually different, and will produce 24 different apart-codes. Many assemblies which are similar to a given assembly will be analyzed with the same rotation as the given assembly, but others will be analyzed in a different rotation, particularly those which involve cube changes to the first piece. The answer to this problem is to compare the solutions and related Apart-Codes in all of the 24 rotations and reflections, and choose the 'best' or 'standard' one. The rules given above are used extensively for this. The resulting standard solution for the L5 Notchable includes not only an Apart-Code, but the LL format of the rotation chosen from the 24. The LL format of the rotation chosen is:

50501135442002201133442622226060

and the standard Apart-Code is:

```
1126 2146 * 112 2F35 *
```

## The AF Format

The information from the three analyses, including standardization of the Apart-Code, is combined and saved in one line per assembly in files which are called 'AF Format' files. The fields in these files are described below. In order to conserve space, many of the fields which contain a value from 0 to 12 (or possibly higher) are restricted to a one-character field. In these fields, the letters 'A', 'B', 'C', etc. are used to denote values of 10,11,12, respectively.

Field descriptions:

1. Fields which are concerned with the particular assembly:
  - LL Format (original assembly)** - assembly LL Format as discovered by HB6 programs
  - LL Format (rotated assembly)** - LL Format corresponding to reflection or rotation which has the standard Apart-Code
  - Identify** - code to identify where assembly was discovered; 123#0456 means the 456th 'interesting' assembly from case #123
  - L** - length of pieces used, usually the longest piece length for which the assembly can be disassembled (therefore, the highest level solution for that assembly).
  - H** - number of holes (empty cubes) in assembly
  - Lvs** - levels of first two disassemblies; "A-1" means first disassembly at level-10 and that a complete solution was found with the next disassembly having a 1-move solution; "6-0" means a partial solution with level-6.
  - LTyp** - level-type of assembly
  - St** - number of states in disassembly program when solution was found; every state is counted which can be reached in N-1 moves or less, where N is the solution level
  - Ap** - number of different take-apart methods which take the same number of moves
  - Apart-Code** - apart code for first disassembly of this assembly
  - Move1** - code for first move
  - Move2** - code for second move; etc.
2. Fields which are concerned with all assemblies which can be constructed from the same pieces as the original assembly:
  - Asm** - number of different assemblies that can be made with the 6 pieces used in the original assembly
  - Sol** - number of these assemblies that have complete solutions
  - P** - number of these assemblies that have only partial solutions
  - m** - minimum solution level (from those with complete solutions)
  - M** - maximum solution level
  - S** - number of assemblies with solution at maximum level
3. Fields dealing with the set of 6 pieces in the assembly:
  - d** - number of duplicate pieces in the set of 6 pieces
  - s** - number of symmetric pieces

**a** - number of ambiguous pieces

**u** - number of un-notchable pieces

**g** - total unnotchable cross-sections in pieces; when using "notch and glue" technique for constructing piece, this is usually the number of glue joints required

**c** - smallest number of cubes in any of the pieces (minimum=2)

**C** - largest number of cubes in any piece (12 for solid piece)

[Contents](#)

*previous:* [Analyzing Assemblies](#) *next:* [Take-Apart Methods](#)

[Home](#)

[About our Puzzles](#)

[How to Order](#)

[Six Piece Burrs](#)

[Rectilinear Burrs](#)

[Non-Rectilinear Burrs](#)

[Box-Filling Puzzles](#)

[Miscellaneous Puzzles](#)

[Computer Programs](#)

[Booklets](#)

[References](#)

[Other Websites](#)

Copyright 2000-2002 Bill Cutler Puzzles, Inc.



# Take-Apart Methods



billcutlerpuzzles.com

[Contents](#)

*previous:* [Uniqueness and Disassembly](#) *next:* [Anything Else?](#)

One final analysis remains to be done on the 'interesting' assemblies. The results of the Apart-Code determinations saved in the 'AF Format' files are summarized. Assemblies with the same Apart-Code are grouped together. If the only difference between the two Apart-Codes of the assemblies is an '\*' in one or more of the moves, they are still grouped together. During the summarization process, it was noted how many holes each assembly has, and whether the solution was unique.

The resulting summary consists of one line for each different Apart-Code. The line consists of the Apart-Code, the number of assemblies with this Apart-Code, and the number of unique assemblies with this Apart-Code. In addition, an example assembly in LL Format is included. The assembly that appears in the line was chosen with the following rules:

1. Choose a unique assembly, where possible
2. Choose the one with the fewest holes

[Table 8](#) contains the results of this analysis.

The fields appearing in the summary are as follows:

**Apart-Code** - a '#' instead of a '\*' means that some assemblies with this apart-code have alternate solutions at this point, and others do not

**Cnt** - number of assemblies with this Apart-Code

**Uni** - number of unique assemblies with this Apart-Code

**PM** - total pieces moved (some analysts of 6-piece burrs use this number as a level of difficulty)

**LL Format** - example of assembly with this Apart-Code

**L,H,Lvs,Ltyp,Asm,Sol,St** - information about assembly chosen - see AF format above.

[Contents](#)

*previous:* [Uniqueness and Disassembly](#) *next:* [Anything Else?](#)

[Home](#)

[Six Piece Burrs](#)

[Box-Filling Puzzles](#)

[Booklets](#)

[About our Puzzles](#)

[Rectilinear Burrs](#)

[Miscellaneous Puzzles](#)

[References](#)

[How to Order](#)

[Non-Rectilinear Burrs](#)

[Computer Programs](#)

[Other Websites](#)

Copyright 2000-2002 Bill Cutler Puzzles, Inc.

# Anything Else?



billcutlerpuzzles.com

[Contents](#)

*previous:* [Take-Apart Methods](#) *next:* [Examples](#)

Now that this computer analysis has been completed, in which all 35.5 billion 6-piece burr assemblies were analyzed, is there anything left to analyze in the way of 6-piece burrs? Are there any more interesting designs to discover? The answer is, of course, "Yes". In some areas the computer analysis is incomplete. There are also some situations which are beyond the capabilities of the current computer programs.

Interesting 6-piece burr designs which were overlooked or not included in the computer analysis are broken into 3 categories:

## Standard Pieces, Standard Moves

In this category are questions which could be answered by computer programs similar to the ones used in the analysis, but were not included because of time constraints or other reasons.

1. Complete solution analysis - only high level solutions were completely disassembled. How many of the 5,951,254,866 partial solutions can be completed?
2. Different definitions of level - other definitions of level are frequently made. What assemblies have the highest level first move with other definitions of level?
3. Instead of considering only the level of the first move, what about considering the total number of moves to disassemble the burr? The GENDA program handles complete disassembly of a burr and minimizes the level at each stage of the disassembly, but this does not necessarily minimize the total number of moves made. Although solving such a problem can definitely be done with a program, there is not an easy way to add this logic to the current program.
4. What if external holes are allowed? Using long pieces with notches repeated every few units and 'back-and-forth' movement techniques, one can design 6-piece burrs with as high a level as one desires.

## Standard Pieces, Non-Standard Moves

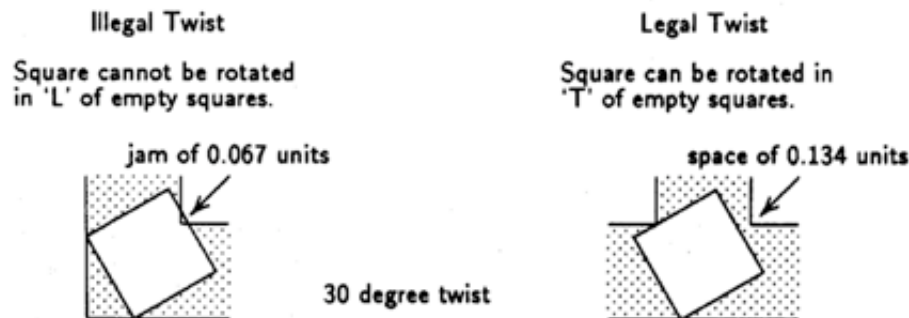
In this category we consider 6-piece burr assemblies which are made up of standard pieces, and so are included in the 35.5 billion assemblies analyzed, but can come apart in unusual ways. The program is limited to movements which are linear in one of the orthogonal directions and are a multiple of the cube width in length. What about 1/2 moves, slant moves and twists? Can these non-standard moves be used to advantage to disassemble one of the standard 6-piece burr assemblies?

The "Weave" in the examples section is an example of a cubic build-up assembly which cannot be disassembled with the "standard" moves above, but which will fall apart easily if the pieces can be moved in other ways. The computer programs used in the analysis are incapable of determining that this puzzle comes apart. Are such designs possible within the confines of a 6-piece burr?

[Diagram of The Weave](#)

I posed this question in 1986 (see [5]). A key restriction was that any such move be completely "legal". By this I mean that if the pieces were cut perfectly from a rigid material with no tolerance or extra space whatsoever, then the pieces can be physically separated using the rotations.

At the time I asked this question regarding the 6-piece burr, I thought the answer was probably "no", but I had not really tried to construct such a design. When the Computer's Choice 4-Hole design was discovered in 1988, I noticed there was a twist movement in the puzzle. The twist is equivalent to rotating a square within 3 squares the same size in the shape of an 'L'. See figure below. In theory, the twist is illegal. In practice, the twist can be made even with well-made pieces because the sides of the 'L' hole are different pieces, so that the 'play' in the pieces is magnified. Although the move is illegal and does not help the disassembly process if it is made, this discovery made me realize the possibilities for similar, legal movements, and I started investigating assemblies with such movements.



The first design I came up with required a fully-legal twist for disassembly, but unfortunately the solution was not unique (there were different ways to assemble the puzzle which had standard solutions). Imagine my surprise when, about two weeks later, I received a design from Peter Rosler (GERMANY) with the identical twist move in a very similar design. This design was also not unique. By this time, I was running programs on all similar assemblies looking for one with a unique twist solution.

After doing an exhaustive search of about 2,000 assemblies, I found 2 unique designs, one of which is now called "The Programmer's Nightmare". Running BURR6 on this design produces "102 assemblies with no solution". One of the assemblies has the twist move which was originally planned. However, there are 3 other assemblies which also appear to have twist moves that will result in disassembly. In two of these assemblies the twist moves are equivalent to the illegal twist move described above, and are therefore not legitimate solutions. With well-made pieces, these moves cannot be made without noticing that the pieces 'jam'. On first glance, the twist move in the third assembly appears to be every bit as legal as the original solution. I was disappointed when I first found this out, because an equivalent additional assembly appears in all of the 6-piece burr designs with similar twist moves. However, on closer examination both moves have additional restrictions in another layer of the assembly. The original solution turns out to be completely legal, and the third assembly illegal, but even with well-made pieces there is little evidence of the 'jam'. See the following pages for detailed pictures:

[Programmer's Nightmare Solution](#)

[Programmer's Nightmare Three Close Solutions](#)

[Programmer's Nightmare Rotation in Legal Solution](#)

What about 1/2 moves, in which the moves are linear in the orthogonal directions, but the lengths of the moves are not integral multiples of the cube width? Can they be used to advantage?

In the Programmer's Nightmare, a  $1/2$  move was combined with a twist to disassemble the puzzle. However, I do not see how  $1/2$  moves, or other fractional moves, can be used by themselves to advantage. I cannot conceive of an assembly, built up from cubes in a standard 3-d lattice, in which fractional moves can accomplish anything that full moves cannot. However, I have been wrong before!

What about slant moves, that is, linear moves in a direction other than an orthogonal direction?

In similar fashion to the  $1/2$  move argument, I cannot see how slant moves can allow disassembly of a cubic assembly where standard moves cannot do the same. However, a slant move, or a combination of a  $1/2$  move and a slant move, can replace a number of repeated standard moves that 'jog' a piece in a slanted direction. Hence, the slant move can be used to decrease the number of 'moves' in the solution, but disassembly can still be achieved with standard moves.

## Non-Standard Pieces

In this category are 6-piece burrs in which the pieces are not restricted to the cubic-cut pieces of [Figure 2](#). We can use slant cuts, which may require that two pieces be moved simultaneously in different directions. We can use rounded cross-sections, resulting in twisting moves which are completely legal for these pieces. There are an infinite number of possible piece shapes, and perhaps an infinite variety to the possible uses of such pieces.

A few examples:

- **U-Nam-It Burr** - A long time ago, perhaps 1965, I tried to design a 6-piece burr in which all 6 pieces had to move at the same time in different directions. This was necessitated by slant cuts in pairs of pieces. Unfortunately, when I resurrected the design in 1989, it turned out not to work at all. I modified the design so that 3 pieces must move simultaneously in different directions.

[Diagram of U-Nam-It](#)

- **Explode-A-Burr** - About the same time as the original U-Nam-It design, I crossed the familiar 'star burr' design with the 6-piece burr shape. The result is a standard-looking 6-piece burr in which all 6 pieces are identical and there are no internal holes. The disassembly technique requires all pieces to be moved simultaneously away from the center of the puzzle - a technique which is sometimes referred to as 'explosion'. There are other designs in which all 6 pieces are identical and there are no holes, but I believe all of these are modifications of this design.

[Diagram of Explode-A-Burr](#)

Stewart Coffin has recently been experimenting with 'inclined' 6-piece burr designs. In some of these designs the cross-sections of the pieces are rhombic and in other designs the pieces do not meet each other at right angles. Some of these designs can be analyzed by the same computer programs used in standard 6-piece burr analysis, but for other types of designs these programs are useless.

[Contents](#)

*previous:* [Take-Apart Methods](#) *next:* [Examples](#)

[Home](#)

[Six Piece Burrs](#)

[Box-Filling Puzzles](#)

[Booklets](#)

[About our Puzzles](#)

[Rectilinear Burrs](#)

[Miscellaneous Puzzles](#)

[References](#)

[How to Order](#)

[Non-Rectilinear Burrs](#)

[Computer Programs](#)

[Other Websites](#)

# Examples



billcutlerpuzzles.com

[Contents](#)

*previous:* [Anything Else?](#) *next:* [References](#)

This section contains many examples of 6-piece burrs. A brief description is given below, including date of design, designer, and method of design. Love's Dozen, Computer's Choice Unique-10, and Programmer's Nightmare are described in detail. For other standard 6-piece burr designs, consult [Table 12](#) and the LL Format description to see how the pieces fit together.

**Bill's Baffling Burr** - March 3, 1984 - unique level-5 - Bill Cutler - probably the first "computer-assisted" burr design, this was described in the Computer Recreations column of Scientific American [6]. Unfortunately, the picture of one of the pieces was incorrect (corrected in some foreign language editions).

**The Piston Puzzle** - 1986 - unique level-9 - Peter Marineau came up with this design by hand. Before this design, the highest unique solution known was level-7.

**L5 Notchable** - 1987 - unique level-5 - exhaustive computer search by Bill Cutler - the highest level for unique solutions in notchable 6-piece burrs is 5. This is one of 139 such designs.

**Love's Dozen** - 1987 - non-unique level-12 - Bruce Love - Using the definition of level in this booklet, this is the highest level possible to remove the first piece in a 6-piece burr, and there are no other level-12's and no level-11's at all.

[Love's Dozen LL Format to Assembly](#)

[Love's Dozen Computer Output](#)

**Computer's Choice 3-Hole** - 1988 - unique level-7 - exhaustive computer search by Bill Cutler & others - after the completion of the analysis of all 2.5 billion 3-hole assemblies, one was chosen as the best. The major requirements were highest level and unique. 198 level-7 3-hole solutions were found, of which 157 are unique.

**Computer's Choice 4-Hole** - 1988 - unique level-8 - exhaustive computer search by Bill Cutler & others - of the 4.7 billion 4-hole assemblies, 15 are level-8, with 13 of these being unique.

[Diagram of the previous 6 puzzles](#)

**Programmer's Nightmare** - 1989 - Bill Cutler computer-assisted design -

[Programmer's Nightmare Solution](#)

[Programmer's Nightmare Three Close Solutions](#)

[Programmer's Nightmare Rotation in Legal Solution](#)

**Bill's Ball-Bearing Burr** - 1986 - level-3 + 'trick' move - computer-assisted design by Bill Cutler - The idea of inserting ball bearings into the interior of a 6-piece burr gave rise to this puzzle. There are 4 internal cubic-holes on the inside in two pairs of 2 adjacent cubes. The design is such that the balls must be rolled to the outside cubes in each of the holes. This is accomplished by spinning the burr so that centrifugal force is used.

**Notchable 1-Hole Level-2** - 1987 - computer search by Bill Cutler - there are only 4 notchable assemblies with one hole which have a level-2 (or higher) solution. One of them was chosen at random.

**Computer's Choice 5-Hole** - 1988 - unique level-9 - exhaustive computer search by Bill Cutler & others - of the 6.5 billion 5-hole assemblies, 23 are level-9, with 21 of these being unique.

**Computer's Choice Unique 10** - 1990 - unique level-10 - exhaustive computer search by Bill Cutler & others - the highest unique level for a 6-piece burr is 10. There are only 18 such assemblies, all of which disassemble in similar fashions.

[Computer's Choice Unique 10 LL Format to Assembly](#)  
[Computer's Choice Unique 10 Computer Output](#)

**Partial Level-6 Solution** - 1987 - notchable partial solution only - computer search by Bill Cutler - this is the highest known level for the first disassembly in a partial solution. There are no level-8 partial solutions, and the 692,888 level-7 assemblies were not saved for running this analysis, so it is unknown if there is a partial level-7 solution.

[Diagram of the previous 6 puzzles](#)

**L46AA Notchable** - 1987 - non-unique level-10 - exhaustive computer search by Bill Cutler - the highest level solution for notchable 6-piece burrs is 10. There are two of these, and this is the one with fewer holes.

**Most ASM - Unique Level-8** - 1990 - computer search - largest number of assemblies (111) for a unique solution, level-8 or higher.

**Most ASM - Notchable Unique Level-5** - 1987 - computer search - largest number of assemblies (480) for a notchable, unique solution, level-5 or higher.

**Different at Lengths 10 & 12** - 1987 - Bruce Love - Many 6-piece burr assemblies have different solutions at lengths of pieces 6, 8 and 10, but few have any difference beyond length 10. What is the longest length for which this difference can exist? I asked this question in [5]. Both Bruce Love and Peter Marineau gave examples of assemblies where there is a difference between length 10 and length 12 pieces. There are no differences past length 12.

**The 139 Burr** - 1989 - impossible object - Bill Cutler & Jerry McFarland - during the course of the 6-piece burr analysis, I kept track of the number of states that were found in analyzing an assembly. There were only a few which passed the 100 mark, and some of these would not disassemble at all. The largest number of states that can be achieved without coming apart is 139. Several notchable 6-piece burrs with length 10 pieces have this property. I chose one of these and challenged Jerry to manufacture them in some way. They were given out as my souvenir for the 10th International Puzzle Party held in London on August 27, 1989.

[Diagram of the previous 5 puzzles](#)

**U-Nam-It Burr** - 1989 - Bill Cutler - [Diagram of U-Nam-It](#)

**Explode-A-Burr** - 1965 - Bill Cutler - souvenir of the 13th International Puzzle Party in the Netherlands, 1993 - [Diagram of Explode-A-Burr](#)

# The Weave - ?????????????? [Diagram of The Weave](#)

## [Contents](#)

*previous:* [Anything Else?](#) *next:* [References](#)

[Home](#)

[Six Piece Burrs](#)

[Box-Filling Puzzles](#)

[Booklets](#)

[About our Puzzles](#)

[Rectilinear Burrs](#)

[Miscellaneous Puzzles](#)

[References](#)

[How to Order](#)

[Non-Rectilinear Burrs](#)

[Computer Programs](#)

[Other Websites](#)

Copyright 2000-2002 Bill Cutler Puzzles, Inc.

# References



billcutlerpuzzles.com

## [Contents](#)

*previous:* [Examples](#) *next:* [Definitions](#)

1. Appel, K. and W. Haken, the solution of the four-color-map problem, Scientific American, September, 1977, pp. 108-121.
2. Cross, C.A., The Chinese Cross, Pentangle, 1979.
3. Cutler, William, "The Six-Piece Burr", Journal of Recreational Mathematics, vol 10(4), 1977-78, pp.241-250.
4. Cutler, William, unpublished computer analysis, 1973-1977.
5. Cutler, William, "Holey 6-Piece Burr!", 1986.
6. Dewdney, A.K., Computer Recreations column of Scientific American, October, 1985, pp.16-27.
7. Gardner, Martin, Mathematical Games column of Scientific American, January, 1978, pp.14-26.
8. Wyatt, E.M., Puzzles in Wood, 1928, The Bruce Publishing Company, reprinted in 1983 by Woodcraft Supply Corporation.
9. Wyatt, E.M., Wonders in Wood, 1946, The Bruce Publishing Company.

## [Contents](#)

*previous:* [Examples](#) *next:* [Definitions](#)

[Home](#)

[Six Piece Burrs](#)

[Box-Filling Puzzles](#)

[Booklets](#)

[About our Puzzles](#)

[Rectilinear Burrs](#)

[Miscellaneous Puzzles](#)

[References](#)

[How to Order](#)

[Non-Rectilinear Burrs](#)

[Computer Programs](#)

[Other Websites](#)

Copyright 2000-2002 Bill Cutler Puzzles, Inc.



# Definitions



billcutlerpuzzles.com

[Contents](#)

*previous:* [References](#) *next:* [Figures](#)

**Piece Orientation** - a subset of the 12 cubes pictured in [Figure 1](#) which results in a physically connected piece. Of the  $2^{12}$  such combinations, 2225 are connected and 1871 are disconnected.

**Piece (or physical piece)** - one of the 837 physically different shapes which are represented by the 2225 piece orientations. One piece may produce as many as 8 piece orientations.

**Cube Configuration** - an assignment of each of the 32 cubes in [Figure 2](#) to one of the 2 or 3 pieces which may occupy that cube or to empty space. The number of cube configurations is:

$$4^8 * 3^{24} = 18,509,302,102,818,816$$

**Assembly** - A cube configuration in which each of the 6 piece orientations is a physically connected piece. The term 'legal configuration' has also been used this way.

**Fully-Rotated Assembly** - for counting purposes, an assembly in the sense above. An orientation is implied in this definition.

**Physical Assembly** - for counting purposes, two physical assemblies are the same if one can be rotated to match the other.

**Logical Assembly** - two assemblies are the same logical assembly if one can be rotated and/or reflected to produce the second. If a logical assembly has no internal symmetry, then it is equivalent to 2 physical assemblies and 24 fully-rotated assemblies.

**Move** - the linear movement of one or more pieces as a group. The direction must be parallel to one of the 3 axes and the distance must be some multiple of the cube width in length.

**Solution** - an assembly which can be physically disassembled into the 6 individual pieces by a series of moves.

**Level of Solution** - the minimum number of moves required in order to separate the assembly into at least two parts.

**Level-type** - solution levels for an assembly using length-6, length-8, length-10 and length-12 pieces. (e.g. level-type 2-3-0-0 means level 2 with length 6 pieces; level 3 with length 8 pieces, and no solution with length 10 or longer.)

**Partial Solution** - an assembly which can be split into at least two parts with moves (described above). Complete disassembly may or may not be possible.

**Unique Solution** - the physical pieces which are used to make a particular assembly can frequently be used to make other, different assemblies. If only one of the assemblies which can be formed from these pieces

has a solution (can be taken completely apart), then this solution is called a unique solution.

**Assembly with Movement** - some moves with the pieces are possibly, but no disassembly is possible.

**State** - an arrangement of the pieces which can be reached by moves as described above. A state is uniquely described by the displacements of each piece in the 3 directions from its original position, with one of the 6 pieces being held fixed.

**Notchable Piece** - a piece which can be cut from a square rod of wood by making cuts perpendicular to the axis of the rod with repeated passes of a regular blade or with a dado blade. Generally speaking, notchable pieces have no "inside" corners or other areas that would require chiseling parts out or gluing cubes in.

**Notchable Assembly (Solution)** - an assembly (solution) in which each of the 6 pieces is notchable.

**Ambiguous Piece** - a piece which can be rotated about its long axis in more than one way for placement in an assembled 6-piece burr without creating external holes.

**Apart Code** - a shorthand notation for denoting the method for removing the first piece from an assembly. This allows for easy comparison of moves between two different assemblies.

## Computer-Associated Definitions

**GENDA** (GENeral DisAssembly program) - used to analyze interlocking puzzles built up from cubes to see if they can be taken apart.

**FDA** (Fast Disassembly Analysis) - a fast version of the GENDA program which finds partial solutions of 6-piece burrs only.

**BURR6** - an assembly & disassembly program used for 6-piece burrs. The program determines all ways 6 given pieces can be assembled into a 6-piece burr, and then uses the GENDA routines to complete the analysis.

**MATR** - formula for converting a physical 6-piece burr piece with some of its 12 cubes removed into a number from 1-4096. The resulting matrix can then be used to quickly rule out disconnected pieces, identify duplicate pieces, and other tasks. See section III.C.

**LL** - a simple, compact way of representing a 6-piece burr assembly. It consists of 32 1-digit numbers from 0-6. See Section IV.D. and the Love's Dozen and Computer's Choice Unique-10 examples.

**JRM** (for Journal of Recreational Mathematics) - earliest 6-piece burr analysis which was restricted to solid, notchable solutions. See [3].

**SCIAM** (for Scientific American) - analysis of solid, general (un-notchable) 6-piece burr solutions. See [2], [4] and [7].

**NOTC** - analysis of holey, notchable 6-piece burrs.

**HB6** - analysis of holey, general 6-piece burrs.

**GB6** - first phase of HB6 analysis which was used to analyze holey 6-piece burrs with from 0 to 5 holes.

**IB6** - programs used in the HB6 analysis for assemblies with from 16 to 20 holes.

[Contents](#)

*previous:* [References](#) *next:* [Figures](#)

[Home](#)

[Six Piece Burrs](#)

[Box-Filling Puzzles](#)

[Booklets](#)

[About our Puzzles](#)

[Rectilinear Burrs](#)

[Miscellaneous Puzzles](#)

[References](#)

[How to Order](#)

[Non-Rectilinear Burrs](#)

[Computer Programs](#)

[Other Websites](#)

Copyright 2000-2002 Bill Cutler Puzzles, Inc.

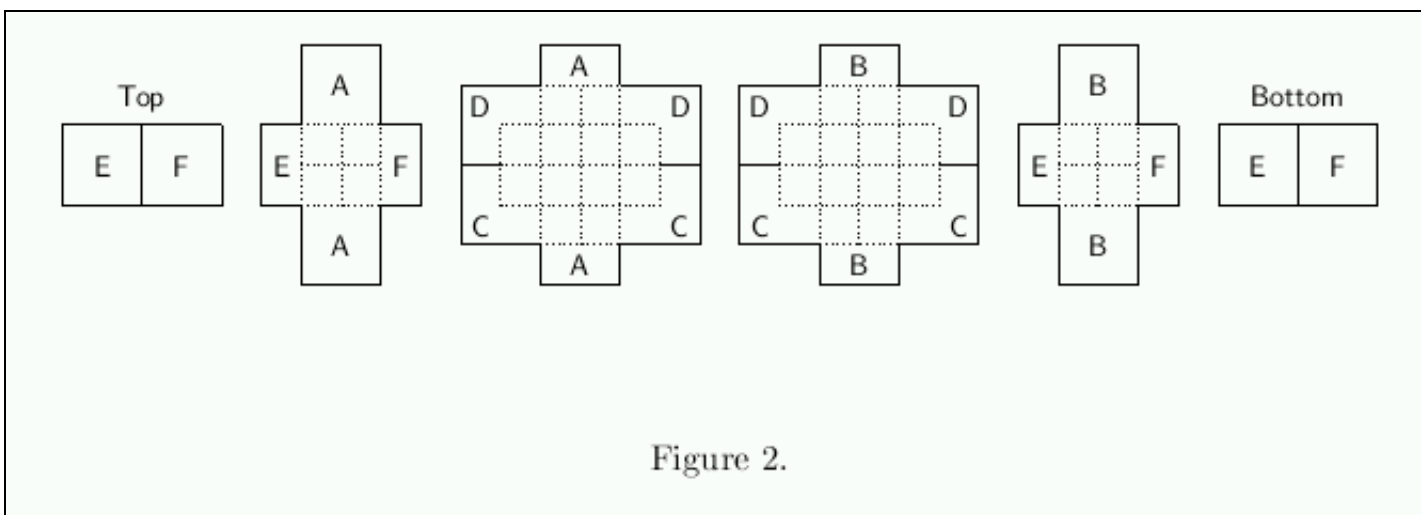
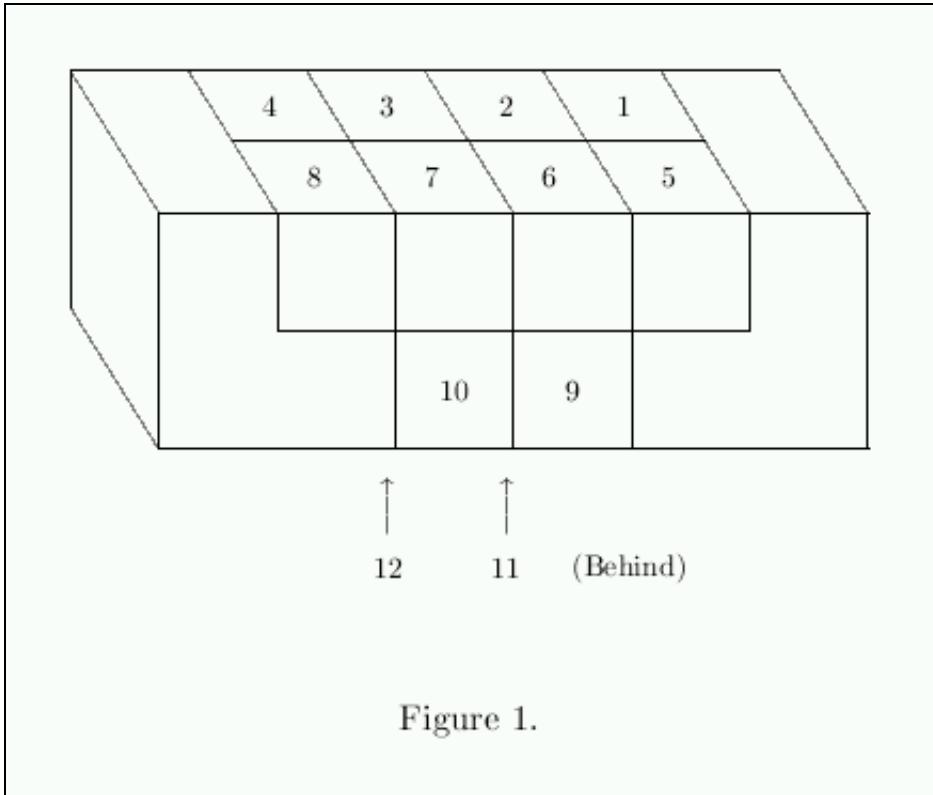
# Figures



billcutlerpuzzles.com

[Contents](#)

previous: [Definitions](#) next: [Tables](#)



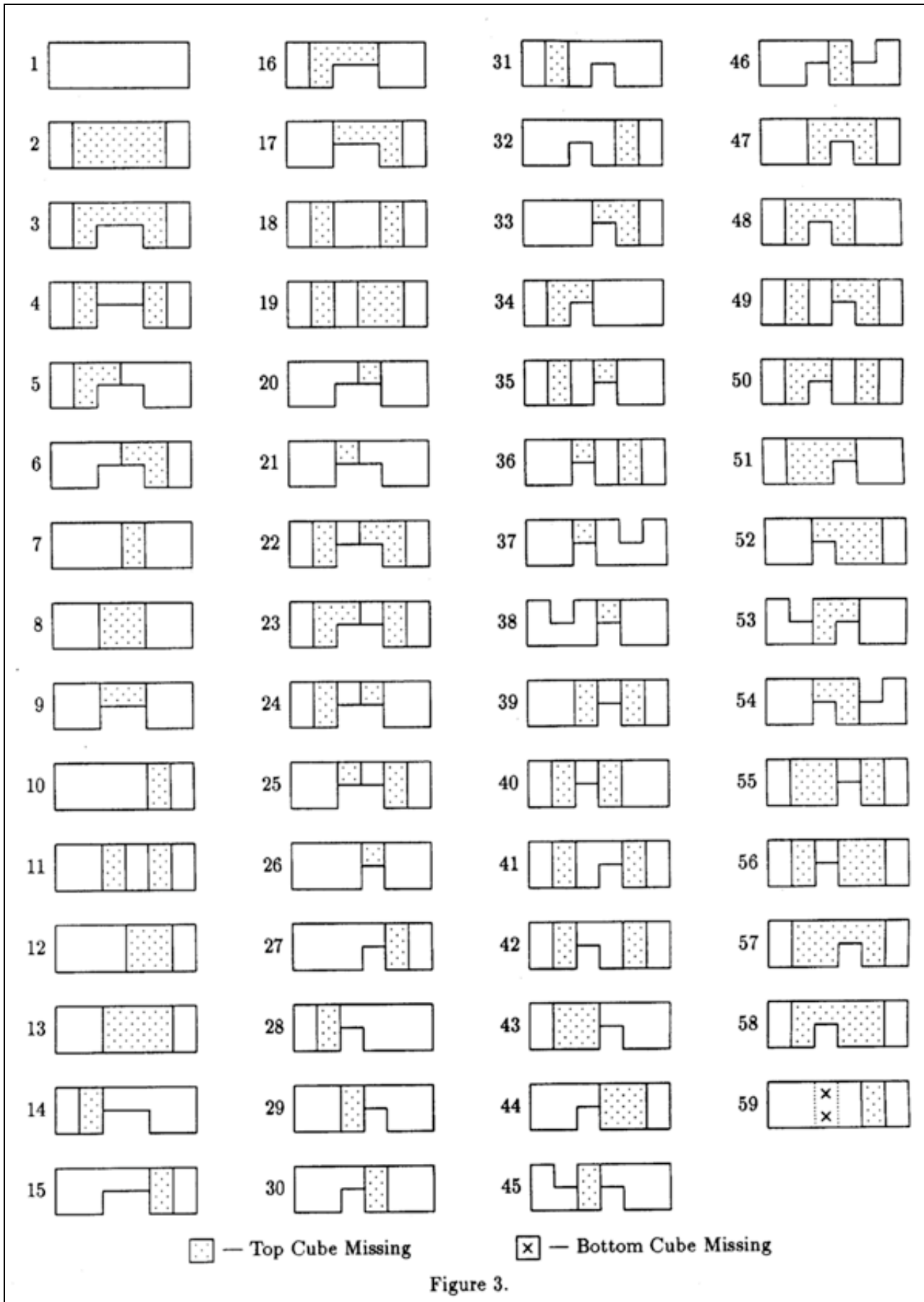


Figure 3.

[Contents](#)

*previous:* [Definitions](#) *next:* [Tables](#)

Home  
About our Puzzles  
How to Order

Six Piece Burrs  
Rectilinear Burrs  
Non-Rectilinear Burrs

Box-Filling Puzzles  
Miscellaneous Puzzles  
Computer Programs

Booklets  
References  
Other Websites

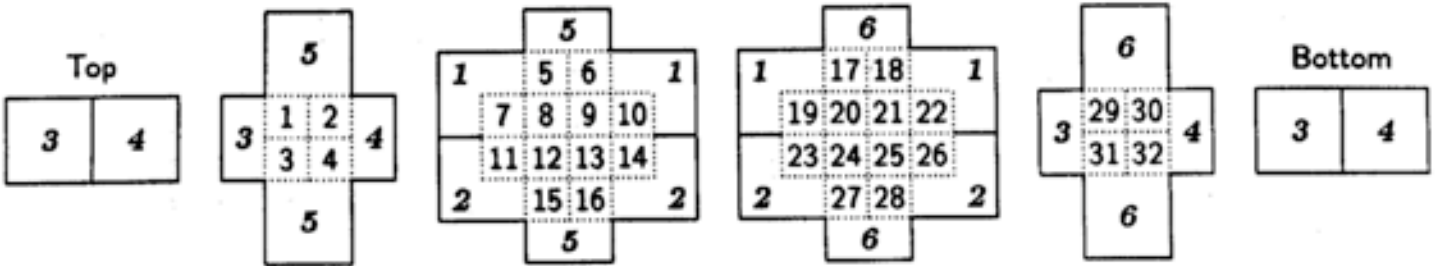
Copyright 2000-2002 Bill Cutler Puzzles, Inc.

Example: Love's Dozen LL Format to Assembly

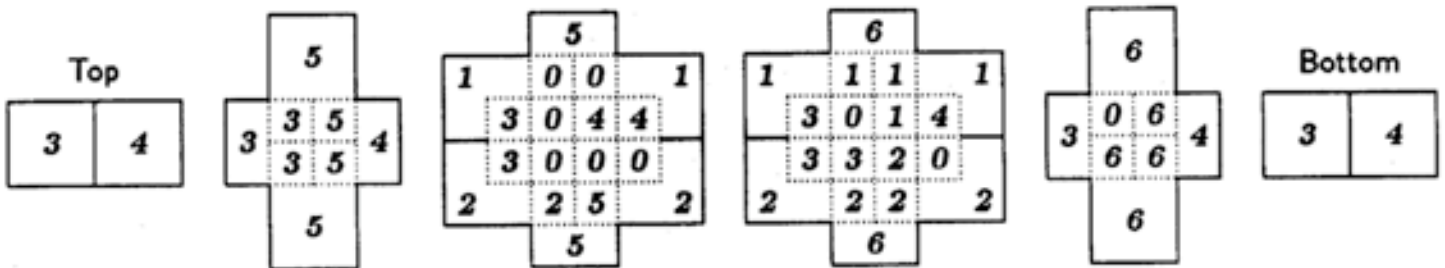
Step 1: Start with LL Format

35350030443000251130143320220666 0 9 212 0 0 0 Love's Dozen

and Figure 2:

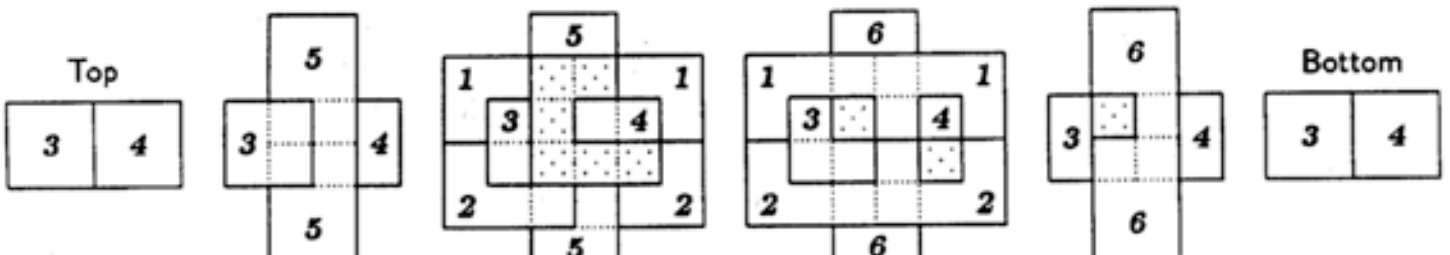


Step 2: Replace cube numbers in Figure 2 with 32 cube numbers from LL.



Step 3:

- a. Combine cubes together with like numbers to pieces with the same number.
- b. Cubes '0' are empty.
- c. Leave length of pieces at 6.



Love's Dozen

- STARTING POSITION

TOP

```

*****
*      *      *      *      *      *      *      *      *      *
*      *      *      *      *      *      *      *      *      *
*      *      *      *      55      *      55      *      66      *      66      *      *
*      *      *      *      55      *      11 11      *      111111      *      66      *      *
*      *      *      *      3344      *      3354      *      13 441      *      13 141      *      3 64      *      3344      *
*      *      *      *      3344      *      3354      *      23 2      *      2332 2      *      3664      *      3344      *
*      *      *      *      55      *      222522      *      222222      *      66      *      *      *
*      *      *      *      55      *      55      *      66      *      66      *      *      *
*      *      *      *      *      *      *      *      *      *      *      *      *
*      *      *      *      *      *      *      *      *      *      *      *      *
*****

```

DIR # 2

A

|  
|  
|  
|

DIR # 3 < - - - - -

+-----> DIR # 1

LEVEL 12 SOLUTION FOUND:

- LEVEL 1: IN DIR # 2 MOVE PIECES: 4:-1
- LEVEL 2: IN DIR # 3 MOVE PIECES: 1: 1
- LEVEL 3: IN DIR # 2 MOVE PIECES: 6:-1
- LEVEL 4: IN DIR # 3 MOVE PIECES: 3:-2
- LEVEL 5: IN DIR # 2 MOVE PIECES: 6: 1
- LEVEL 6: IN DIR # 3 MOVE PIECES: 1:-1
- LEVEL 7: IN DIR # 2 MOVE PIECES: 5:-1
- LEVEL 8: IN DIR # 2 MOVE PIECES: 4: 1
- LEVEL 9: IN DIR # 3 MOVE PIECES: 2: 1
- LEVEL 10: IN DIR # 2 MOVE PIECES: 1: 1 6: 1
- LEVEL 11: IN DIR # 1 MOVE PIECES: 1: 1
- LEVEL 12: PIECES SPLIT IN DIRECTION 3 INTO:
  - (NEG DIRECTION) - SUBASSEMBLY # 1 PIECES: 2 3 4 5 6
  - (POS DIRECTION) - SINGLE PIECE 1

Love's Dozen

- SUBASSEMBLY # 1

TOP

```

*****
*      *      *      *      *      *      *      *      *      *
*      *      *      *      *      *      *      66      *      66      *      *
*      *      *      *      *      *      *      *      *      *      66      *      *
*      *      *      *      55      *      55      *      *      *      6      *      *
*      *      *      *      44      *      554      *      3344      *      33 4      *      3664      *      3 44      *
*      *      *      *      44      *      2 542      *      2332 2      *      33      *      3664      *      3344      *
*      *      *      *      222522      *      222222      *      66      *      66      *      *      *
*      *      *      *      55      *      5      *      *      *      *      *      *
*      *      *      *      55      *      55      *      *      *      *      *      *
*      *      *      *      *      *      *      *      *      *      *      *      *
*****

```

DIR # 2

A

|  
|  
|  
|

DIR # 3 < - - - - -

+-----> DIR # 1

LEVEL 3 SOLUTION FOUND:

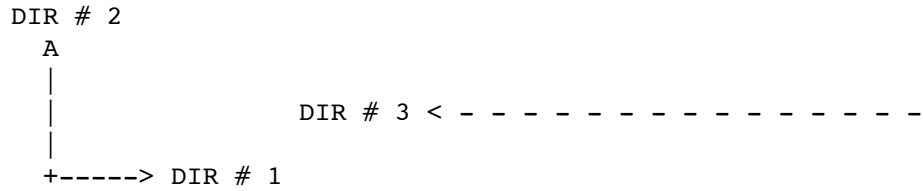


LEVEL 1: IN DIR # 2 MOVE PIECES: 6:-2  
 LEVEL 2: IN DIR # 3 MOVE PIECES: 2:-1  
 LEVEL 3: PIECES SPLIT IN DIRECTION 1 INTO:  
           (NEG DIRECTION) - SUBASSEMBLY # 2 PIECES: 2 3  
                                   SINGLE PIECE 5  
                                   SINGLE PIECE 6  
           (PoS DIRECTION) - SINGLE PIECE 4

Love's Dozen - SUBASSEMBLY # 2  
 TOP

```

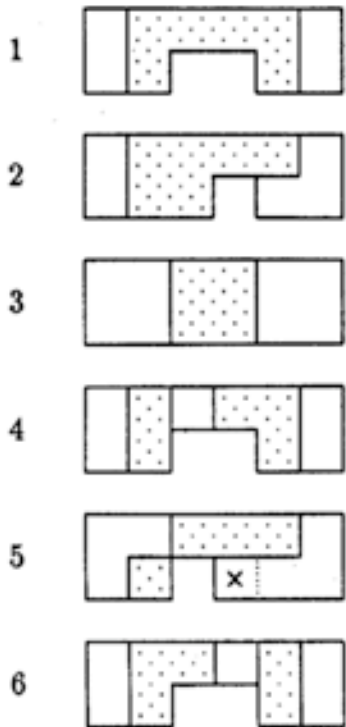
*****
*           *           *           *           *           *           *           *           *
*           *           *           *           *           *           *           *           *
*           *           *           *           *           *           *           *           *
*           *           *           *           *           *           *           *           *
*           *           *           *           *           *           *           *           *
*           *           *           *           *           *           *           *           *
*           *           *           *           *           *           *           *           *
*           *           *           *           *           *           *           *           *
*           *           *           *           *           *           *           *           *
*           *           *           *           *           *           *           *           *
*           *           *           *           *           *           *           *           *
*****
  
```



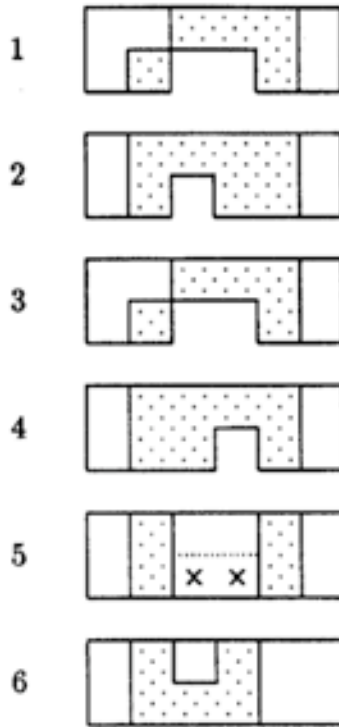
LEVEL 1 SOLUTION FOUND:  
 LEVEL 1: PIECES SPLIT IN DIRECTION 2 INTO:  
           (NEG DIRECTION) - SINGLE PIECE 2  
           (PoS DIRECTION) - SINGLE PIECE 3

DISASSEMBLY COMPLETE

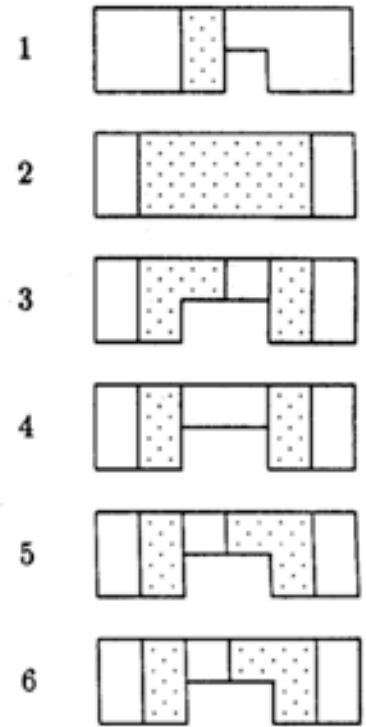
### Bill's Baffling Burr



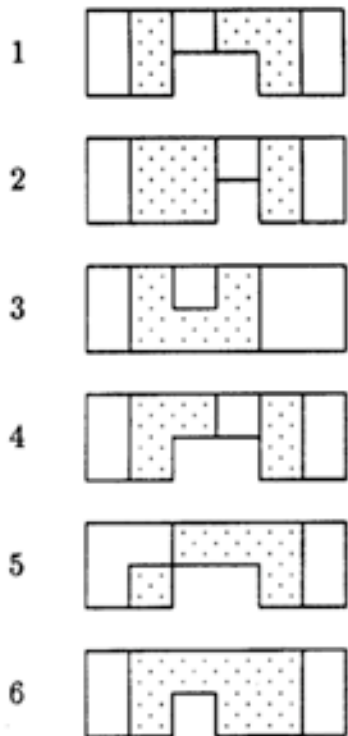
### The Piston Puzzle



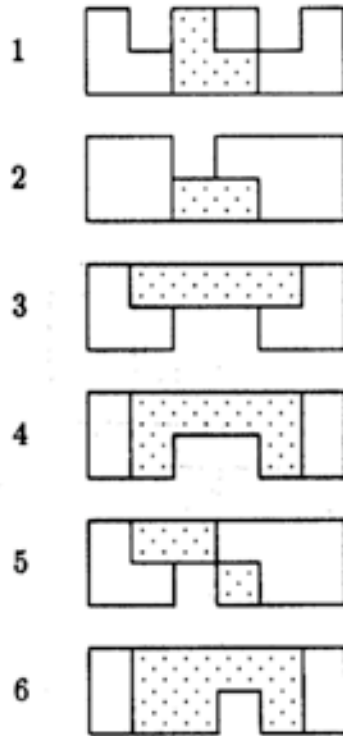
### L5 Notchable



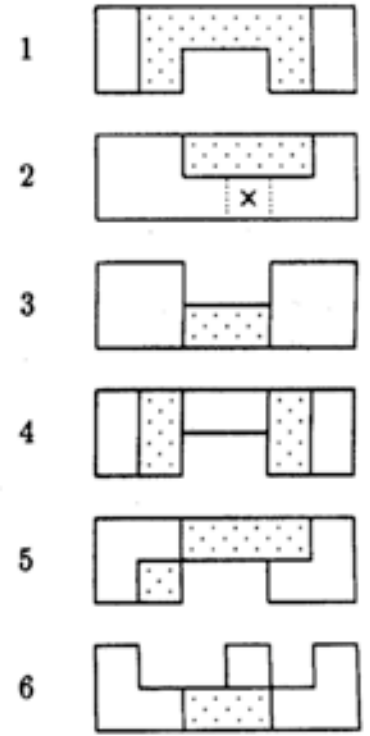
### Love's Dozen





### Computer's Choice 3 - Hole



### Computer's Choice 4 - Hole



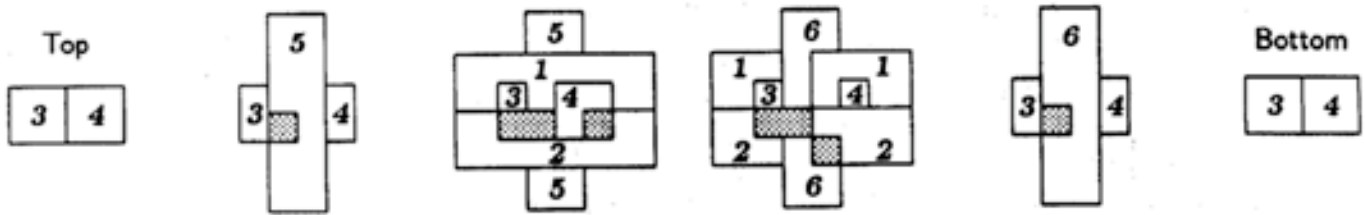
 — Top Cube Missing

 — Bottom Cube Missing

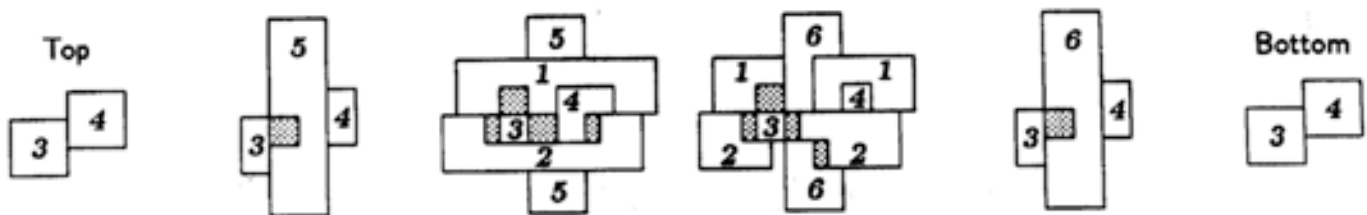
### Programmer's Nightmare Solution

#### Disassembly Steps

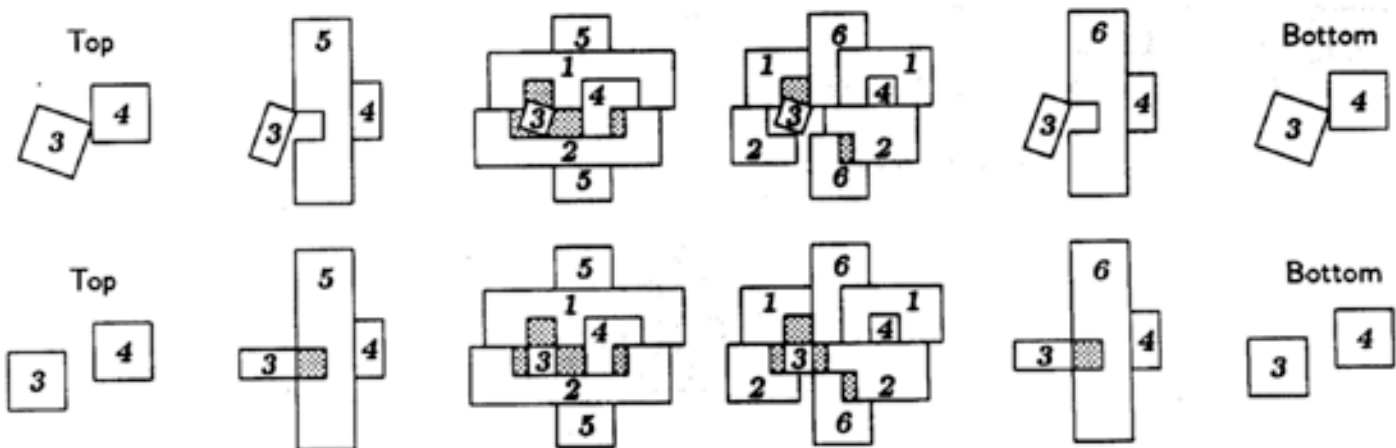
##### 1. Starting Position



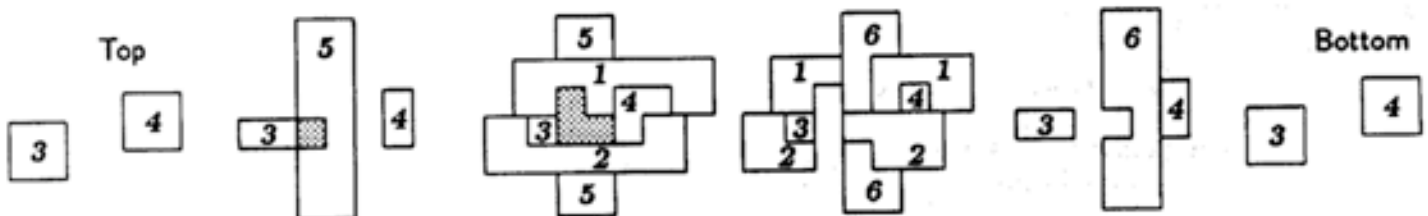
##### 2. Move piece 3 down one unit and piece 2 left one-half unit.



##### 3. Rotate piece 3 clockwise 90 degrees.



##### 4. Move pieces 3 and 5 one unit left and piece 2 one-half unit left.



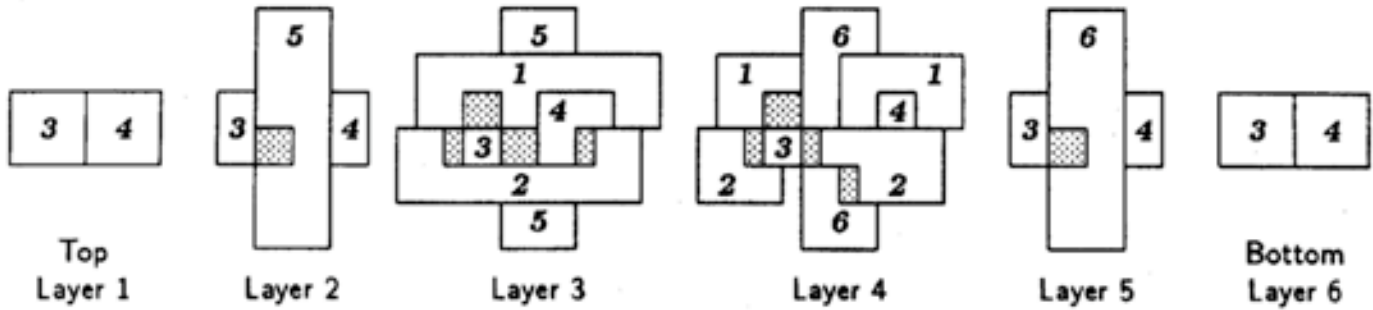
##### 5. Remove piece 5 to TOP of assembly.

6. Continue disassembly by removing piece 3 next.

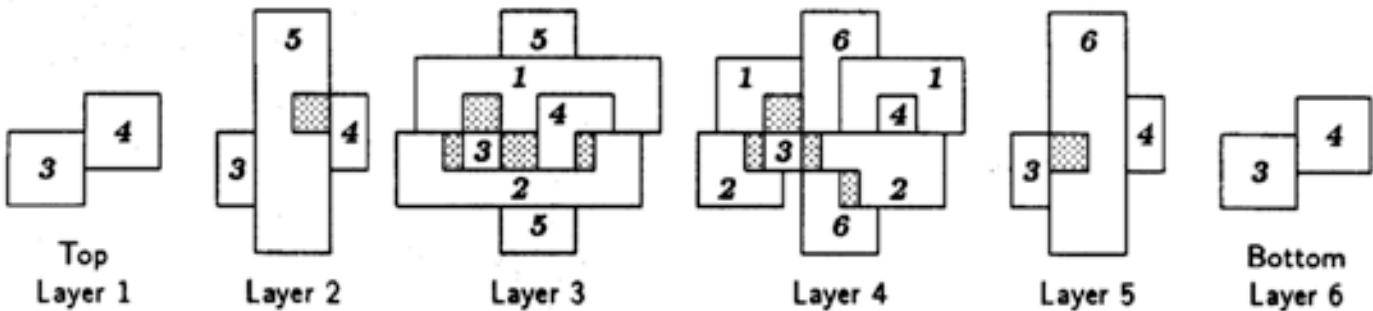
### Programmer's Nightmare Three Close Solutions

There are 102 assemblies, none of which have any 'normal' solutions. Four assemblies have potential 'twist' solutions, but only one is legal. Assemblies are shown at time prior to rotation.

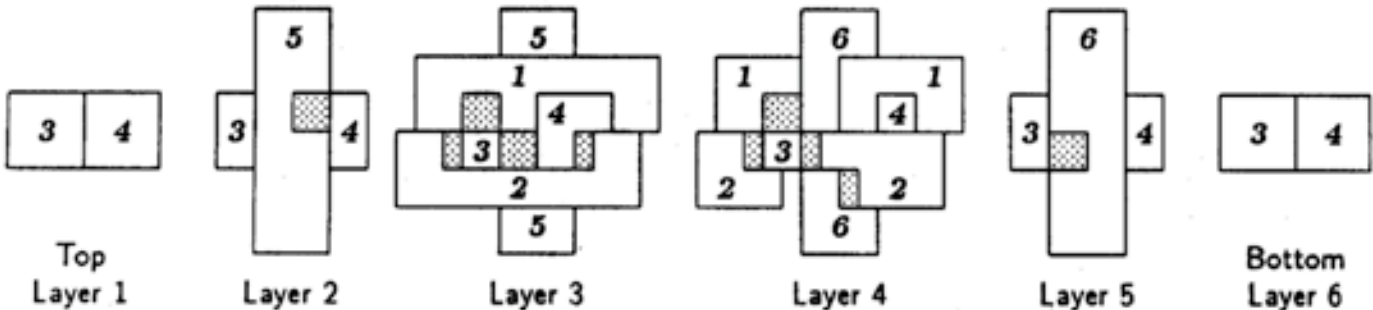
Close-1: Piece 3 is flipped end-for-end.



Close-2: Piece 5 is flipped end-for-end.



Close-3: Pieces 3 and 5 are flipped end-for-end.



The twists in Close-2 and Close-3 are equivalent to the Illegal Twist below because the twists must be made in Layer 2 as well as in Layer 3.

#### Illegal Twist

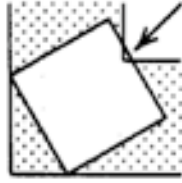
Square cannot be rotated  
in 'L' of empty squares.

jam of 0.067 units

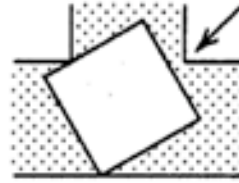
#### Legal Twist

Square can be rotated in  
'T' of empty squares.

space of 0.134 units

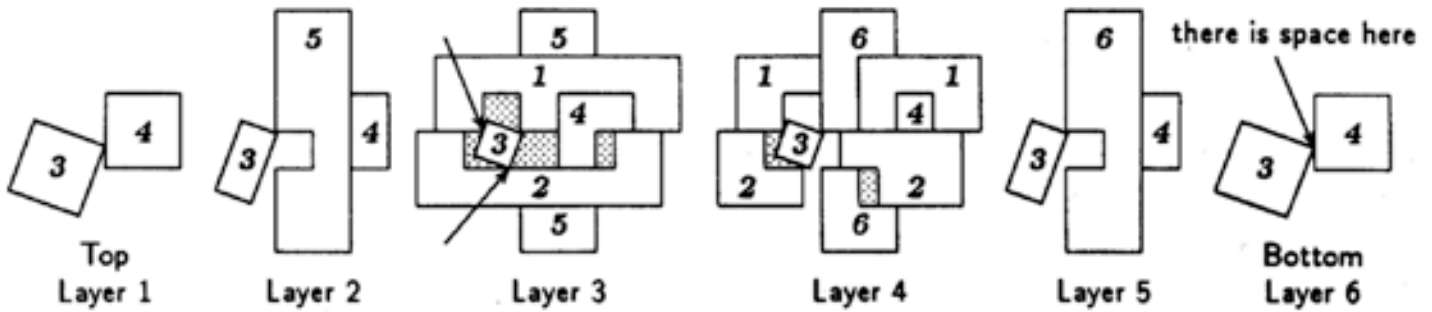


30 degree twist



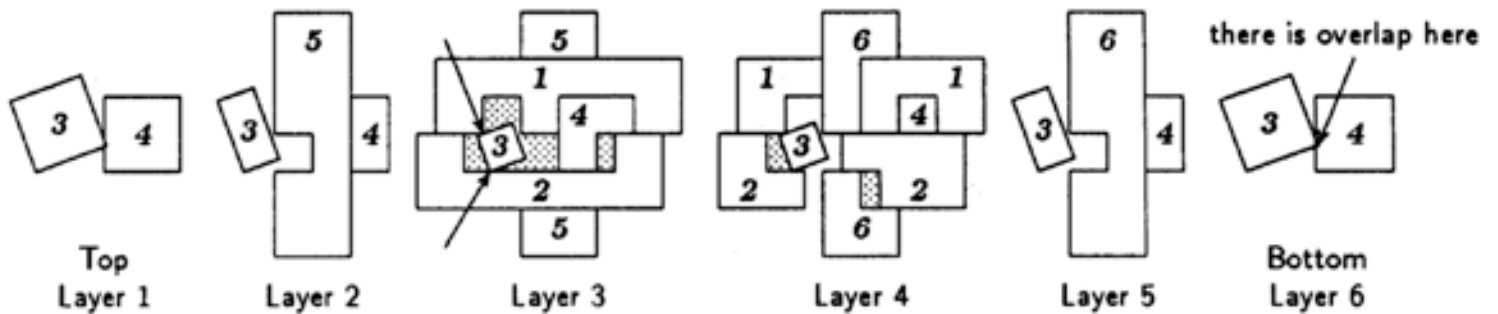
### Programmer's Nightmare Rotation in Legal Solution

Position of pieces in correct solution at 20 degrees. Maintain two points of tangency as indicated in Layer 3.



### Rotation in Illegal Solution, Close-1

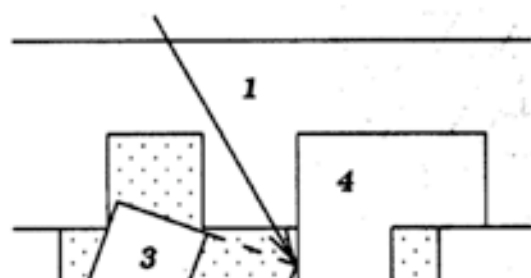
Position of pieces in incorrect solution at 20 degrees. Maintain two points of tangency as indicated in Layer 3.



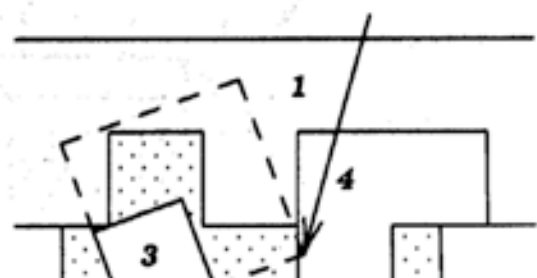
Legal

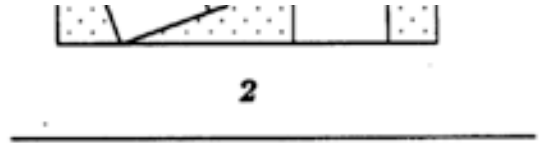
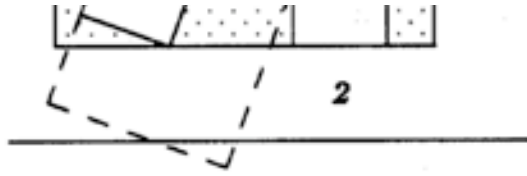
Illegal

0.0181 unit clearance



0.0557 unit overlap





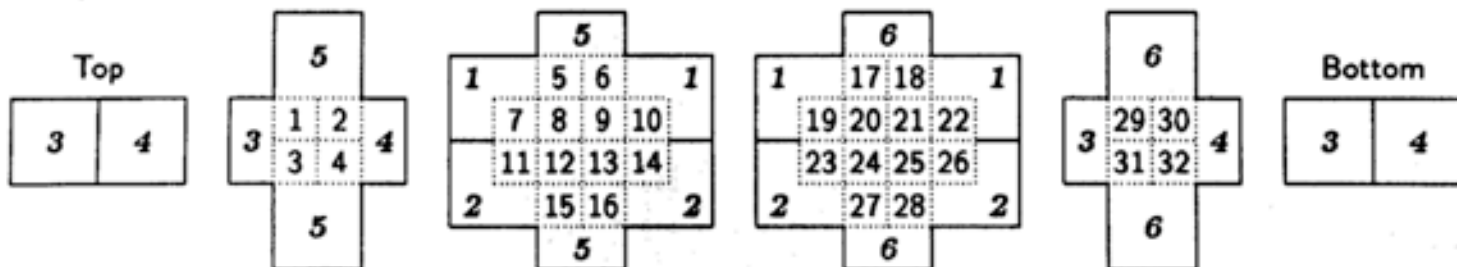


Example: Computer's Choice Unique - 10, LL Format to Assembly

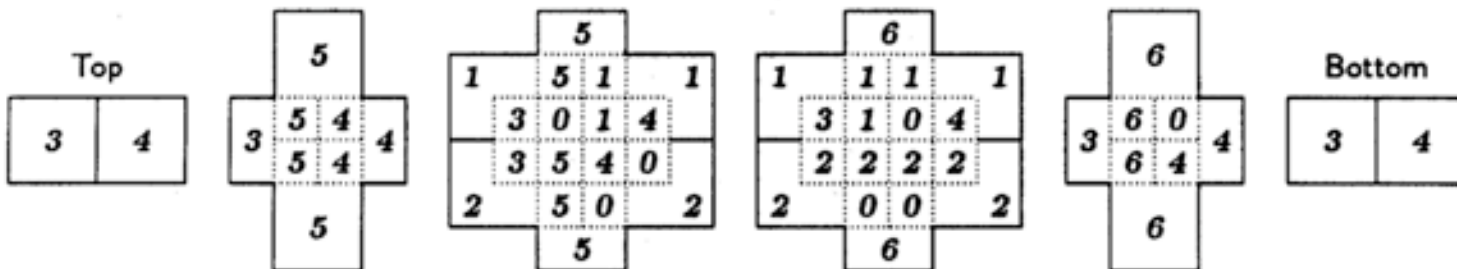
Step 1: Start with LL Format

54545130143540501131042222006064 0 7 3 510 0 0 Computer's Choice Unique-10

and Figure 2:

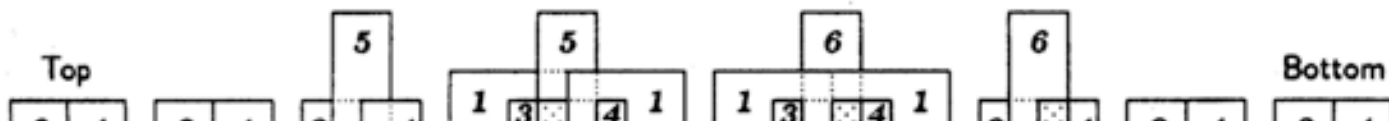


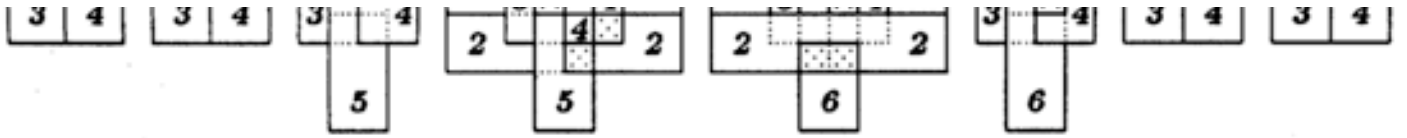
Step 2: Replace cube numbers in Figure 2 with 32 cube numbers from LL.



Step 3:

- a. Combine cubes together with like numbers to pieces with the same number.
- b. Cubes '0' are empty.
- c. Modify length of pieces to length 8.





TOP

```

*****
*      *      *      *      *      *      *      *      *      *
*      *      *      *      55      *      55      *      66      *      66      *      *
*      *      *      *      55      *      55      *      66      *      66      *      *
*      *      *      *      55      *      11151111 *      11111111 *      66      *      *
*      *      3344 *      3344 *      3544      *      113 1411 *      1131 411 *      36 4      *      3344 *
*      *      3344 *      3344 *      3544      *      22354 22 *      22222222 *      3644      *      3344 *
*      *      *      *      *      55      *      2225 222 *      222 222 *      66      *      *
*      *      *      *      *      55      *      55      *      66      *      66      *      *
*      *      *      *      *      55      *      55      *      66      *      66      *      *
*      *      *      *      *      *      *      *      *      *      *      *      *
*****

```

LEVEL 10 SOLUTION FOUND:

LEVEL 1: IN DIR # 2 MOVE PIECES: 2:-1 3:-1

```

*****
*      *      *      *      *      *      *      *      *      *
*      *      *      *      55      *      55      *      66      *      66      *      *
*      *      *      *      55      *      55      *      66      *      66      *      *
*      *      *      *      55      *      11151111 *      11111111 *      66      *      *
*      *      44      *      44      *      544      *      11 1411 *      11 1 411 *      6 4      *      44      *
*      *      3344 *      3344 *      3544      *      354      *      3      *      3644      *      3344 *
*      *      33      *      33      *      355      *      2235 22 *      22222222 *      366      *      33      *
*      *      *      *      *      55      *      22255222 *      22266222 *      66      *      *
*      *      *      *      *      55      *      55      *      66      *      66      *      *
*      *      *      *      *      *      *      *      *      *      *      *      *
*****

```

LEVEL 2: IN DIR # 3 MOVE PIECES: 4: 2

```

*****
*      *      *      *      *      *      *      *      *      *
*      *      *      *      55      *      55      *      66      *      66      *      *
*      *      *      *      55      *      55      *      66      *      66      *      *
*      *      *      *      55      *      11151111 *      11111111 *      66      *      *
*      44      *      44      *      4      *      5 4      *      11 1411 *      11 14411 *      644      *      *
*      44      *      3344 *      334      *      35      *      3544      *      3 44      *      3644      *      33      *
*      *      33      *      33      *      355      *      2235 22 *      22222222 *      366      *      33      *
*      *      *      *      *      55      *      22255222 *      22266222 *      66      *      *
*      *      *      *      *      55      *      55      *      66      *      66      *      *
*      *      *      *      *      *      *      *      *      *      *      *      *
*****

```

LEVEL 3: IN DIR # 2 MOVE PIECES: 5: 1

```

*****
*      *      *      *      55      *      55      *      *      *      *      *
*      *      *      *      55      *      55      *      66      *      66      *      *
*      *      *      *      55      *      5      *      66      *      66      *      *
*      *      *      *      5      *      111 1111 *      11111111 *      66      *      *
*      44      *      44      *      4      *      5 4      *      11 51411 *      11 14411 *      644      *      *
*      44      *      3344 *      334      *      355      *      3544      *      3 44      *      3644      *      33      *
*      *      33      *      33      *      355      *      22355 22 *      22222222 *      366      *      33      *
*      *      *      *      *      55      *      22255222 *      22266222 *      66      *      *
*      *      *      *      *      *      *      *      66      *      66      *      *
*      *      *      *      *      *      *      *      *      *      *      *      *
*****

```

LEVEL 4: IN DIR # 1 MOVE PIECES: 1: 1 4: 1

```

*****
*      *      *      *      55      *      55      *      *      *      *      *
*      *      *      *      55      *      55      *      66      *      66      *      *
*      *      *      *      55      *      5      *      66      *      66      *      *
*      *      *      *      5      *      111 1111 *      11111111 *      66      *      *
*****

```

```
*      44 *      44 *      4 *      5 4 * 115 1411* 11 14411* 6 44 *      *
*      44 *      33 44 *      33 4 *      355 *      35 44 *      3 44 *      36 44 *      33 *
*      *      33 *      33 *      355 * 22355 22 * 22222222 * 366 *      33 *
*      *      *      *      55 * 22255222 * 22266222 * 66 *      *
*      *      *      *      *      *      *      66 *      66 *      *
*      *      *      *      *      *      *      *      *      *
```

LEVEL 5: IN DIR # 3 MOVE PIECES: 4:-2

```
*****
*      *      *      *      55 *      55 *      *      *      *
*      *      *      *      55 *      55 *      66 *      66 *      *
*      *      *      *      55 *      5 *      66 *      66 *      *
*      *      *      *      5 *      111 1111* 11111111* 66 *      *
*      *      44 *      44 *      5 44 * 115 1411* 11 1 411* 6 4 *      44 *
*      *      33 44 *      33 44 *      35544 *      35 4 *      3 *      36 44 *      33 44 *
*      *      33 *      33 *      355 * 22355 22 * 22222222 * 366 *      33 *
*      *      *      *      55 * 22255222 * 22266222 * 66 *      *
*      *      *      *      *      *      *      66 *      66 *      *
*      *      *      *      *      *      *      *      *      *
```

LEVEL 6: IN DIR # 2 MOVE PIECES: 4:-1

```
*****
*      *      *      *      55 *      55 *      *      *      *
*      *      *      *      55 *      55 *      66 *      66 *      *
*      *      *      *      55 *      5 *      66 *      66 *      *
*      *      *      *      5 *      111 1111* 11111111* 66 *      *
*      *      *      *      5 *      115 1 11* 11 1 11* 6 *      *
*      *      33 44 *      33 44 *      35544 *      35 4 *      3 4 *      36 4 *      33 44 *
*      *      33 44 *      33 44 *      35544 * 22355422 * 22222222 * 36644 *      33 44 *
*      *      *      *      55 * 22255222 * 22266222 * 66 *      *
*      *      *      *      *      *      *      66 *      66 *      *
*      *      *      *      *      *      *      *      *      *
```

LEVEL 7: IN DIR # 1 MOVE PIECES: 1:-1

```
*****
*      *      *      *      55 *      55 *      *      *      *
*      *      *      *      55 *      55 *      66 *      66 *      *
*      *      *      *      55 *      5 *      66 *      66 *      *
*      *      *      *      5 *      111 1111 * 11111111 * 66 *      *
*      *      *      *      5 *      11 51 11 * 11 1 11 * 6 *      *
*      *      33 44 *      33 44 *      35544 *      35 4 *      3 4 *      36 4 *      33 44 *
*      *      33 44 *      33 44 *      35544 * 22355422 * 22222222 * 36644 *      33 44 *
*      *      *      *      55 * 22255222 * 22266222 * 66 *      *
*      *      *      *      *      *      *      66 *      66 *      *
*      *      *      *      *      *      *      *      *      *
```

LEVEL 8: IN DIR # 2 MOVE PIECES: 3: 1 5: 1

```
*****
*      *      *      *      55 *      55 *      *      *      *
*      *      *      *      55 *      5 *      66 *      66 *      *
*      *      *      *      5 *      *      66 *      66 *      *
*      *      *      *      5 *      11151111 * 11111111 * 66 *      *
*      *      33 *      33 *      355 * 11351 11 * 1131 11 * 36 *      33 *
*      *      33 44 *      33 44 *      35544 *      355 4 *      4 *      36 4 *      33 44 *
*      *      44 *      44 *      5544 * 22 55422 * 22222222 * 6644 *      44 *
*      *      *      *      *      *      222 222 * 22266222 * 66 *      *
*      *      *      *      *      *      *      66 *      66 *      *
*      *      *      *      *      *      *      *      *      *
```

LEVEL 9: IN DIR # 1 MOVE PIECES: 2: 1 4: 1 6: 1

```

*****
*           *           *           *           55           *           55           *           *           *           *
*           *           *           *           55           *           5           *           66           *           66           *           *
*           *           *           *           5           *           *           *           66           *           66           *           *
*           *           *           *           5           *           111511111 *           111111111 *           66           *           *
*           *           33           *           33           *           355           *           11351 11 *           1131 11 *           3 6           *           33           *
*           *           33 44 *           33 44 *           355 44 *           355 4 *           4 *           3 6 4 *           33 44 *
*           *           44 *           44 *           55 44 *           2255 422*           22222222*           6644 *           44 *
*           *           *           *           *           *           222 222*           22266222*           66 *           *
*           *           *           *           *           *           *           *           66 *           66 *           *
*           *           *           *           *           *           *           *           *           *           *
*****

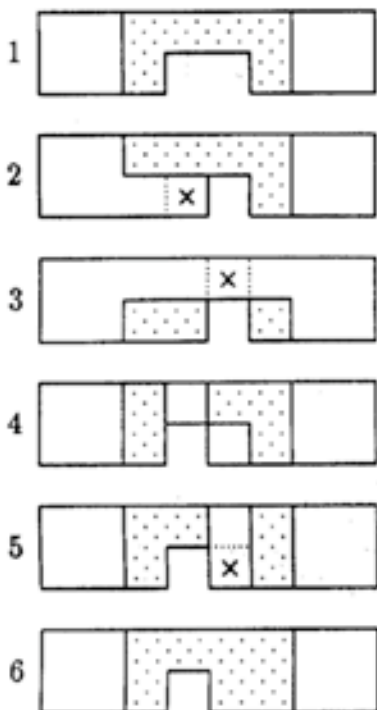
```

LEVEL 10: PIECES SPLIT IN DIRECTION 3 INTO:

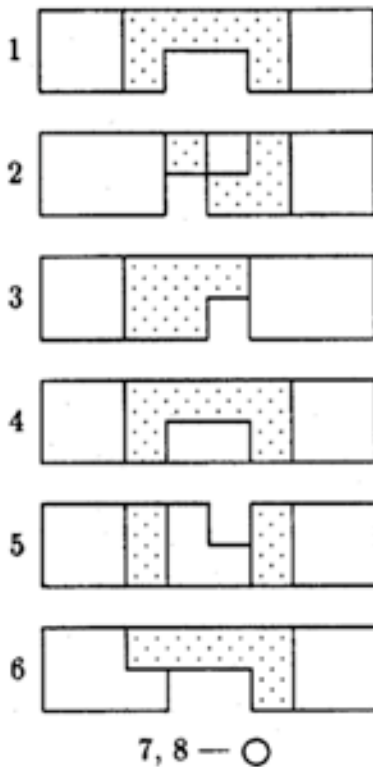
- (NEG DIRECTION) - SINGLE PIECE 6
  - SUBASSEMBLY # 1 PIECES: 2 4
- (POS DIRECTION) - SUBASSEMBLY # 2 PIECES: 1 3 5

ALL SUBASSEMBLIES SUCCESSFULLY DISASSEMBLED

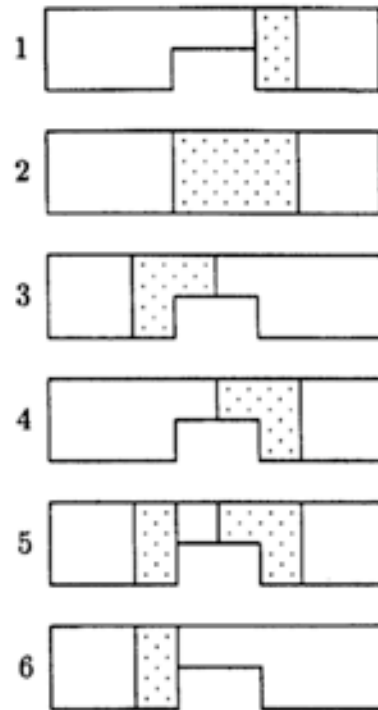
### Programmer's Nightmare



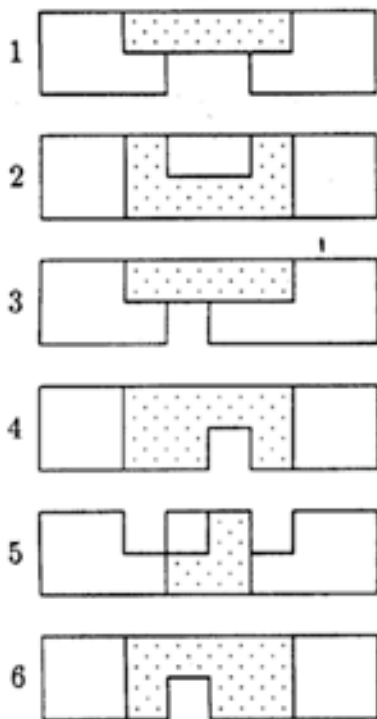
### Bill's Ball Bearing Burr



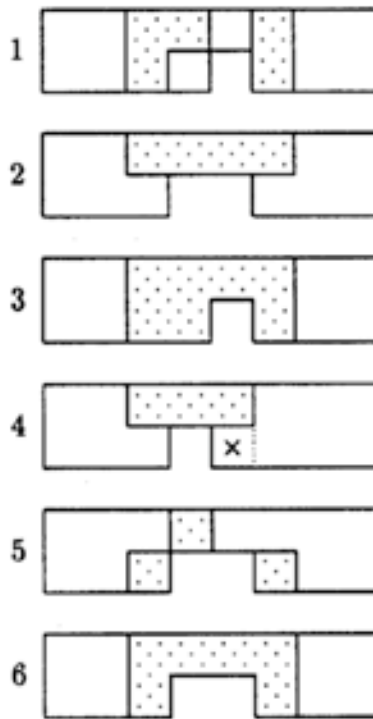
### Notchable 1 - Hole Level - 2



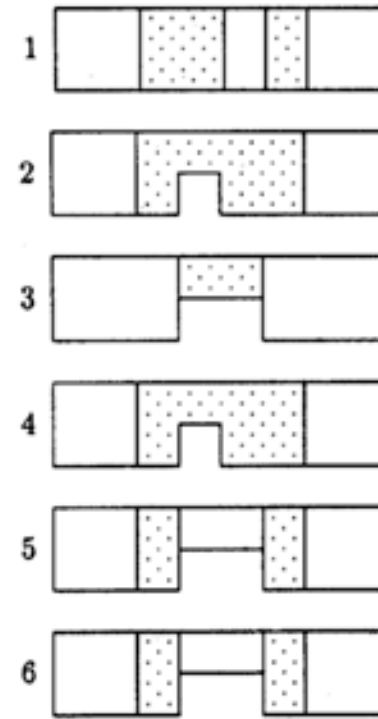
### Computer's Choice 5 - Hole



### Computer's Choice Unique - 10




### Level - 6 Partial Solution



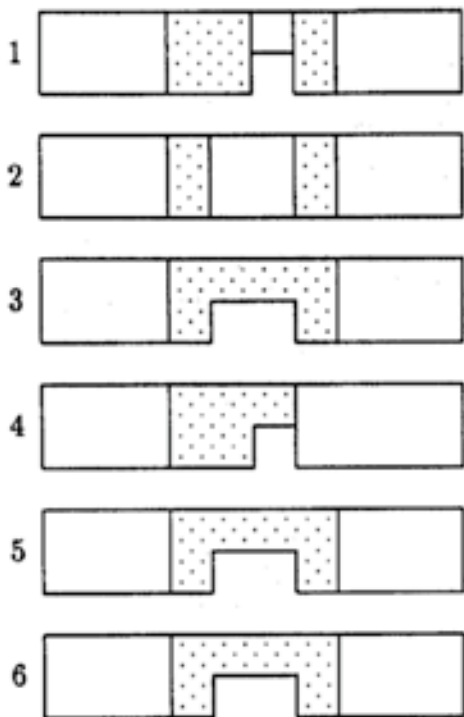
Bottom Cube Mixing

Bottom Cube Mixing

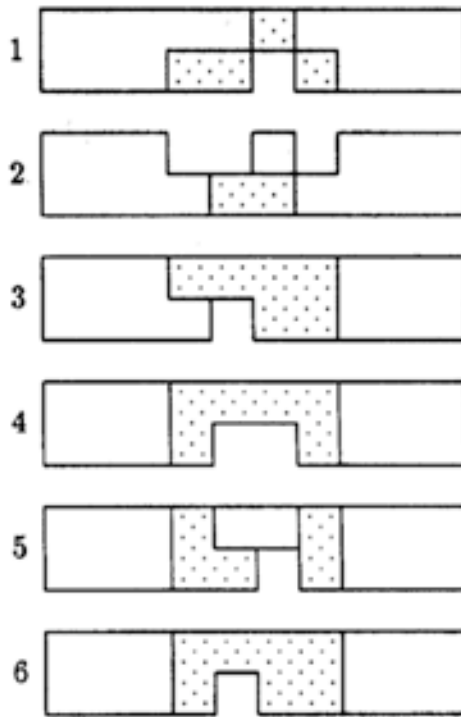
 — Top Cube Missing

 — Bottom Cube Missing

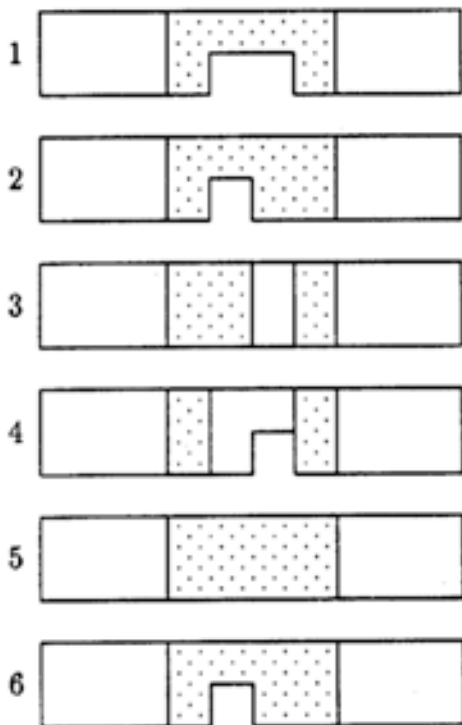
**L46AA Notchable**



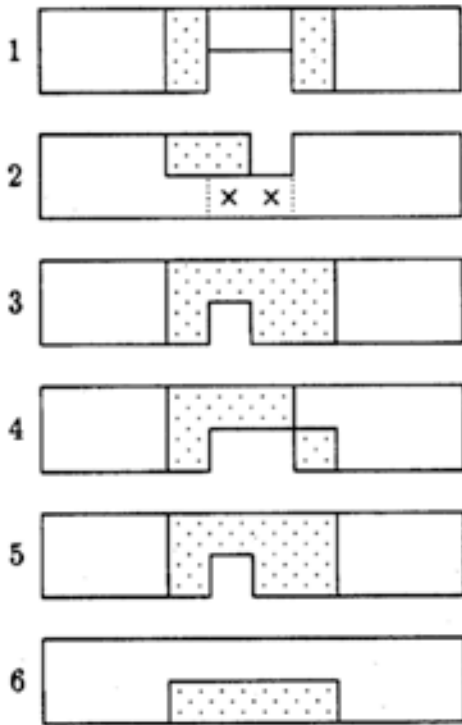
**Most ASM  
Unique Level - 8**



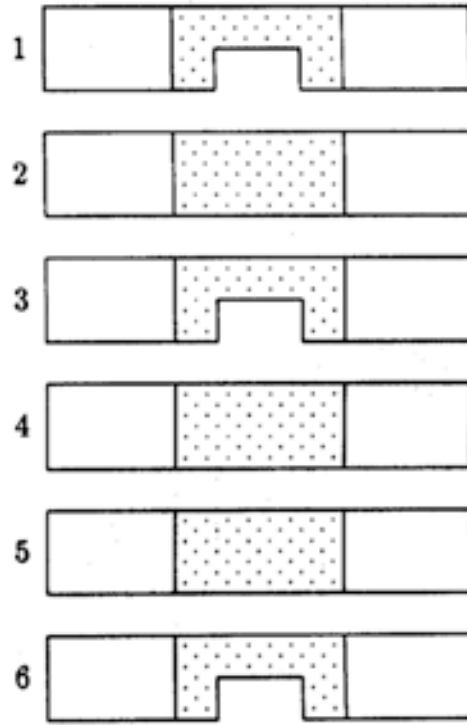
**Most ASM  
Notch Level - 5**



**Different at Lengths  
10 and 12**



**The 139 Burr**



— Top Cube Missing

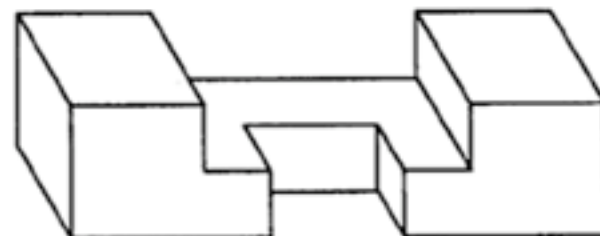
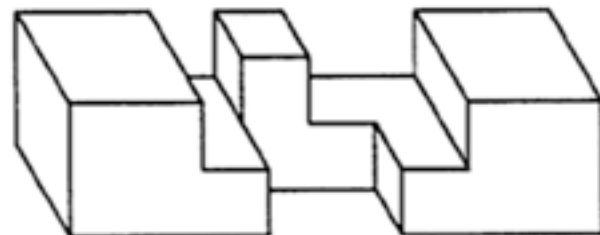
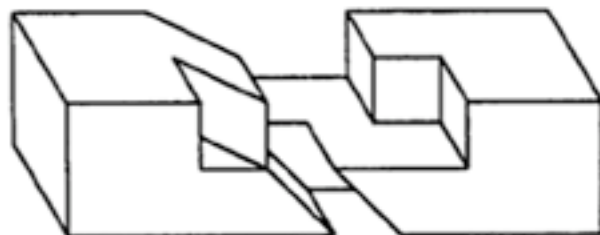
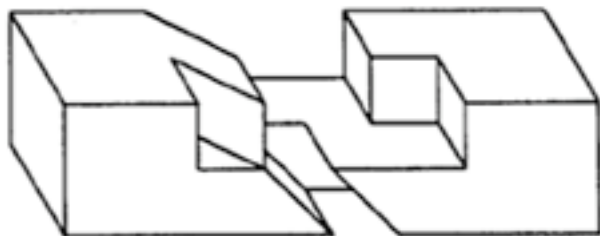
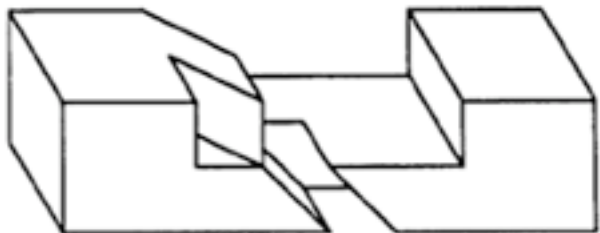
— Bottom Cube Missing

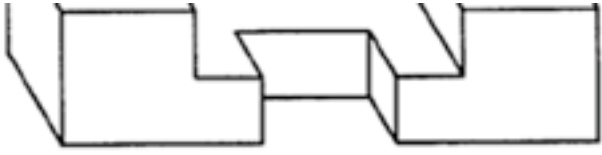


Top Cube missing

Bottom Cube missing

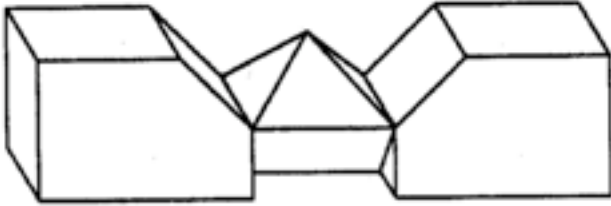
# U-Nam-It Burr





# Explode-A-Burr

Six of these pieces form a 6-piece burr.



# Weave

Made from four pieces of the same shape.

The computer is unable to disassemble these pieces.

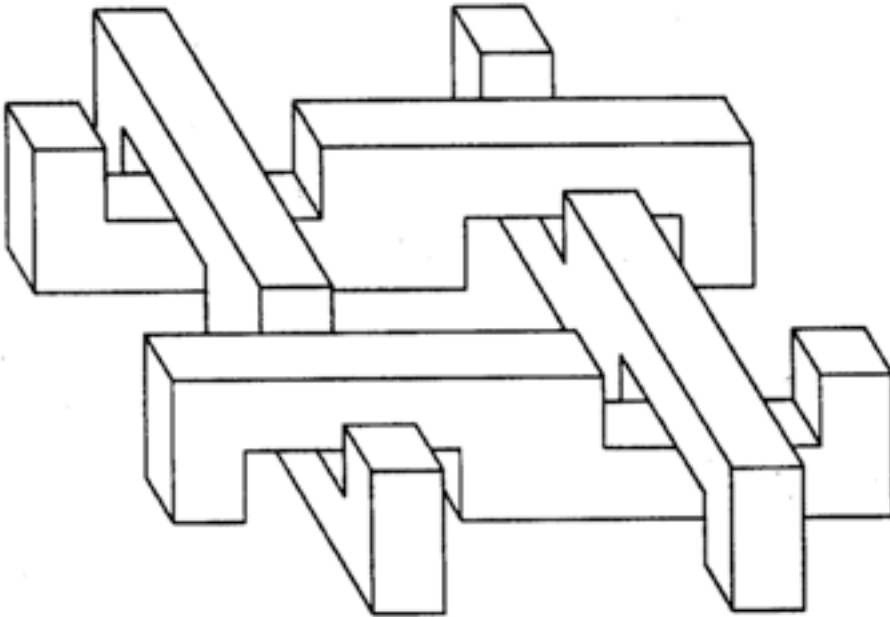


Table 1 - Summary of 6-Piece Burr Analyses

Analysis	JRM	SCIAM	NOTC	HB6
Notchable ?	yes	no	yes	no
Solid ?	solid	solid	holey	holey
<b>Pieces</b>				
Different	25	369	59	837
Complete Set	42	485	? (a)	? (a)
Piece Orientations	50	790	147	2225
<b>Solutions</b>				
Logical	179	60,186	7.4 million	5.75 billion (b)
Physical	314	119,979	14.8 million	11.50 billion (b)
<b>Partial Solutions &amp; Solutions</b>				
Logical	181	78,777	7,458,937	5,951,254,866
Physical	318	157,122	14,913,154	11,902,446,737
<b>Assemblies</b>				
Logical	588	25,062,952	13,354,991	35,657,131,235
Physical	1,063	50,122,724	26,704,015	71,314,165,174
Fully-Rotated	12,597	601,456,869	320,439,782	855,769,655,392
<b>Cube Configuration Counts</b>				
Solid	110,075,314,176		Holey 18,509,302,102,818,816	
<b>Maximum Solution Levels</b>				
	level=1	level=1	maximum=10 unique=5	maximum=12 unique=10
Reference	JRM [3]	SCIAM [2],[4],[7]	---this booklet---	

Notes:

(a) The number of pieces for a complete set to construct all possible holey 6-piece burrs is of little interest. Pieces with few cubes can be used with many duplicates, but the resulting assemblies would be loose and fall apart easily. In addition, many interesting assemblies need pieces of length 8, 10 or 12, so a complete set would consist of different lengths of most piece shapes as well as duplicates.

(b) Counts for complete solutions remain unknown. The numbers here are estimates based on complete analysis of a random sample of 5,588 un-notchable assemblies.

Table 2 - 837 Physical Pieces

Pce	O	Nt	S	Bit	Codes	Pce	O	Nt	S	Bit	Codes	Pce	O	Nt	S	Bit	Codes
1	1	1	Y	1111	1111 11 11	71	1	0	N	1010	0101 11 11	141	4	0	N	0010	1111 01 11
2	4	0	N	0111	1111 11 11	72	2	0	N	0010	0101 11 11	142	4	0	N	1100	1111 01 11
3	8	0	N	1011	1111 11 11	73	2	0	Y	0100	0101 11 11	143	4	0	N	0100	1111 01 11
4	4	0	N	0011	1111 11 11	74	2	0	N	1000	0101 11 11	144	4	0	N	1000	1111 01 11
5	4	0	N	0101	1111 11 11	75	2	0	Y	0000	0101 11 11	145	4	0	N	0000	1111 01 11
6	4	0	N	1001	1111 11 11	76	4	0	N	0111	1001 11 11	146	2	0	Y	0111	0111 01 11
7	4	0	N	0001	1111 11 11	77	4	0	Y	0011	1001 11 11	147	4	0	N	1011	0111 01 11
8	2	0	N	0110	1111 11 11	78	4	0	N	0101	1001 11 11	148	2	0	Y	0011	0111 01 11
9	4	0	N	0010	1111 11 11	79	4	8	Y	1001	1001 11 11	149	4	0	N	1101	0111 01 11
10	2	0	N	0000	1111 11 11	80	4	0	Y	0001	1001 11 11	150	2	0	Y	0101	0111 01 11
11	2	10	Y	0111	0111 11 11	81	4	0	N	0110	1001 11 11	151	4	0	N	1001	0111 01 11
12	4	0	N	1011	0111 11 11	82	4	0	N	0010	1001 11 11	152	2	0	Y	0001	0111 01 11
13	2	0	Y	0011	0111 11 11	83	4	0	N	0100	1001 11 11	153	2	0	N	1110	0111 01 11
14	4	0	N	1101	0111 11 11	84	4	0	Y	1000	1001 11 11	154	2	0	N	0110	0111 01 11
15	2	0	Y	0101	0111 11 11	85	4	0	Y	0000	1001 11 11	155	2	0	N	1010	0111 01 11
16	4	0	N	1001	0111 11 11	86	2	0	Y	0111	0001 11 11	156	2	0	N	0010	0111 01 11
17	2	0	Y	0001	0111 11 11	87	2	0	Y	0011	0001 11 11	157	2	0	N	1100	0111 01 11
18	1	0	N	1110	0111 11 11	88	2	0	Y	0101	0001 11 11	158	2	0	N	0100	0111 01 11
19	2	0	N	0110	0111 11 11	89	2	13	Y	0001	0001 11 11	159	2	0	N	1000	0111 01 11
20	2	0	N	1010	0111 11 11	90	2	0	N	0110	0001 11 11	160	2	0	N	0000	0111 01 11
21	2	0	N	0010	0111 11 11	91	2	0	Y	0010	0001 11 11	161	4	0	N	0111	1011 01 11
22	2	0	N	1100	0111 11 11	92	2	0	Y	0100	0001 11 11	162	8	26	Y	1011	1011 01 11
23	2	0	N	0100	0111 11 11	93	1	0	N	1000	0001 11 11	163	4	0	Y	0011	1011 01 11
24	2	0	N	1000	0111 11 11	94	2	0	Y	0000	0001 11 11	164	8	0	Y	1101	1011 01 11
25	2	0	N	0000	0111 11 11	95	1	0	N	0111	1110 11 11	165	4	0	N	0101	1011 01 11
26	4	0	N	0111	1011 11 11	96	2	0	N	0011	1110 11 11	166	8	0	Y	1001	1011 01 11
27	8	7	Y	1011	1011 11 11	97	2	0	N	0101	1110 11 11	167	4	0	Y	0001	1011 01 11
28	4	0	Y	0011	1011 11 11	98	2	0	N	0001	1110 11 11	168	4	0	N	1110	1011 01 11
29	4	0	N	1101	1011 11 11	99	2	0	N	0110	1110 11 11	169	4	0	N	0110	1011 01 11
30	4	0	N	0101	1011 11 11	100	2	0	N	0010	1110 11 11	170	4	0	N	1010	1011 01 11
31	8	0	Y	1001	1011 11 11	101	2	0	N	0100	1110 11 11	171	4	0	N	0010	1011 01 11
32	4	0	Y	0001	1011 11 11	102	2	0	N	0000	1110 11 11	172	4	0	N	1100	1011 01 11
33	4	0	N	0110	1011 11 11	103	2	0	N	0011	0110 11 11	173	4	0	N	0100	1011 01 11
34	4	0	N	1010	1011 11 11	104	2	0	N	0101	0110 11 11	174	4	0	N	1000	1011 01 11
35	4	0	N	0010	1011 11 11	105	2	0	N	0001	0110 11 11	175	4	0	N	0000	1011 01 11
36	4	0	N	1100	1011 11 11	106	1	18	Y	0110	0110 11 11	176	2	27	Y	0111	0011 01 11
37	4	0	N	0100	1011 11 11	107	2	0	Y	0010	0110 11 11	177	4	0	Y	1011	0011 01 11
38	4	0	N	1000	1011 11 11	108	2	0	Y	0100	0110 11 11	178	2	33	Y	0011	0011 01 11
39	4	0	N	0000	1011 11 11	109	2	0	Y	0000	0110 11 11	179	4	0	Y	1101	0011 01 11
40	2	0	Y	0111	0011 11 11	110	2	0	N	0011	1010 11 11	180	2	0	Y	0101	0011 01 11
41	4	0	Y	1011	0011 11 11	111	1	0	N	0101	1010 11 11	181	4	0	Y	1001	0011 01 11
42	2	12	Y	0011	0011 11 11	112	2	0	N	0001	1010 11 11	182	2	0	Y	0001	0011 01 11
43	2	0	Y	0101	0011 11 11	113	2	0	Y	0010	1010 11 11	183	2	0	N	1110	0011 01 11
44	4	0	Y	1001	0011 11 11	114	2	0	N	0100	1010 11 11	184	2	0	N	0110	0011 01 11
45	2	0	Y	0001	0011 11 11	115	2	0	Y	0000	1010 11 11	185	2	0	N	1010	0011 01 11
46	2	0	N	0110	0011 11 11	116	2	0	Y	0011	0010 11 11	186	2	0	Y	0010	0011 01 11
47	2	0	N	1010	0011 11 11	117	2	0	Y	0001	0010 11 11	187	2	0	N	1100	0011 01 11
48	2	0	Y	0010	0011 11 11	118	2	19	Y	0010	0010 11 11	188	2	0	N	0100	0011 01 11
49	1	0	N	1100	0011 11 11	119	1	0	Y	0100	0010 11 11	189	2	0	N	1000	0011 01 11
50	2	0	N	0100	0011 11 11	120	2	0	Y	0000	0010 11 11	190	2	0	Y	0000	0011 01 11
51	2	0	N	1000	0011 11 11	121	1	0	N	0011	1100 11 11	191	4	0	N	0111	1101 01 11
52	2	0	Y	0000	0011 11 11	122	2	0	N	0001	1100 11 11	192	8	0	N	1011	1101 01 11
53	4	0	N	0111	1101 11 11	123	2	0	N	0010	1100 11 11	193	4	0	N	0011	1101 01 11
54	4	0	N	1011	1101 11 11	124	2	0	Y	0000	1100 11 11	194	4	0	N	0101	1101 01 11
55	4	0	N	0011	1101 11 11	125	2	0	Y	0001	0100 11 11	195	8	0	Y	1001	1101 01 11
56	4	0	N	0101	1101 11 11	126	1	0	Y	0010	0100 11 11	196	4	0	N	0001	1101 01 11

57	8	0	Y	1001	1101	11	11	127	2	0	Y	0000	0100	11	11	197	4	0	N	1110	1101	01	11
58	4	0	N	0001	1101	11	11	128	1	0	N	0001	1000	11	11	198	4	0	N	0110	1101	01	11
59	4	0	N	0110	1101	11	11	129	2	0	Y	0000	1000	11	11	199	4	0	N	1010	1101	01	11
60	4	0	N	1010	1101	11	11	130	1	2	Y	0000	0000	11	11	200	4	0	N	0010	1101	01	11
61	4	0	N	0010	1101	11	11	131	4	0	N	0111	1111	01	11	201	4	0	Y	1100	1101	01	11
62	4	0	N	0100	1101	11	11	132	4	0	N	1011	1111	01	11	202	4	0	N	0100	1101	01	11
63	4	0	Y	1000	1101	11	11	133	4	0	N	0011	1111	01	11	203	4	0	Y	1000	1101	01	11
64	4	0	N	0000	1101	11	11	134	4	0	N	1101	1111	01	11	204	4	0	N	0000	1101	01	11
65	2	0	Y	0111	0101	11	11	135	4	0	N	0101	1111	01	11	205	2	0	Y	0111	0101	01	11
66	2	0	Y	0011	0101	11	11	136	8	0	N	1001	1111	01	11	206	4	0	N	1101	0101	01	11
67	2	11	Y	0101	0101	11	11	137	4	0	N	0001	1111	01	11	207	2	0	Y	0101	0101	01	11
68	4	0	N	1001	0101	11	11	138	4	0	N	1110	1111	01	11	208	2	0	N	1110	0101	01	11
69	2	0	Y	0001	0101	11	11	139	4	0	N	0110	1111	01	11	209	2	0	N	0110	0101	01	11
70	2	0	N	0110	0101	11	11	140	4	0	N	1010	1111	01	11	210	2	0	N	1100	0101	01	11

O - Piece Orientations

Nt - Notchable Piece Number

S - Used in Solid Sol

Pce	O	Nt	S	Bit	Codes	Pce	O	Nt	S	Bit	Codes	Pce	O	Nt	S	Bit	Codes						
281	2	0	Y	1100	1010	01	11	351	2	0	Y	0011	0111	10	11	421	4	0	N	0101	1001	10	11
282	2	0	N	0100	1010	01	11	352	2	0	Y	0101	0111	10	11	422	8	20	Y	1001	1001	10	11
283	2	0	Y	1000	1010	01	11	353	4	0	N	1001	0111	10	11	423	4	0	Y	0001	1001	10	11
284	2	0	Y	0000	1010	01	11	354	2	0	Y	0001	0111	10	11	424	4	0	N	1110	1001	10	11
285	2	0	N	0111	0010	01	11	355	2	0	N	1110	0111	10	11	425	4	0	N	0110	1001	10	11
286	4	0	N	1011	0010	01	11	356	2	0	N	0110	0111	10	11	426	4	0	N	1010	1001	10	11
287	2	0	Y	0011	0010	01	11	357	2	0	N	1010	0111	10	11	427	4	0	N	0010	1001	10	11
288	4	0	N	1101	0010	01	11	358	2	0	N	0010	0111	10	11	428	4	0	Y	1100	1001	10	11
289	2	0	N	0101	0010	01	11	359	2	0	N	1100	0111	10	11	429	4	0	N	0100	1001	10	11
290	4	0	N	1001	0010	01	11	360	2	0	N	0100	0111	10	11	430	4	0	Y	1000	1001	10	11
291	2	0	Y	0001	0010	01	11	361	2	0	N	1000	0111	10	11	431	4	0	Y	0000	1001	10	11
292	2	0	N	1110	0010	01	11	362	2	0	N	0000	0111	10	11	432	2	0	Y	0111	0001	10	11
293	2	41	Y	0110	0010	01	11	363	4	0	N	0111	1011	10	11	433	4	0	Y	1011	0001	10	11
294	2	0	Y	1010	0010	01	11	364	8	0	Y	1011	1011	10	11	434	2	44	Y	0011	0001	10	11
295	2	49	Y	0010	0010	01	11	365	4	0	Y	0011	1011	10	11	435	2	0	Y	0101	0001	10	11
296	2	0	N	1100	0010	01	11	366	4	0	N	0101	1011	10	11	436	4	0	Y	1001	0001	10	11
297	2	0	Y	0100	0010	01	11	367	8	0	Y	1001	1011	10	11	437	2	52	Y	0001	0001	10	11
298	2	0	Y	1000	0010	01	11	368	4	0	Y	0001	1011	10	11	438	2	0	N	1110	0001	10	11
299	2	0	Y	0000	0010	01	11	369	4	0	N	1110	1011	10	11	439	2	0	N	0110	0001	10	11
300	2	0	N	0111	1100	01	11	370	4	0	N	0110	1011	10	11	440	2	0	N	1010	0001	10	11
301	4	0	N	1011	1100	01	11	371	4	0	N	1010	1011	10	11	441	2	0	Y	0010	0001	10	11
302	2	0	N	0011	1100	01	11	372	4	0	N	0010	1011	10	11	442	2	0	N	1100	0001	10	11
303	2	0	N	0101	1100	01	11	373	4	0	N	1100	1011	10	11	443	2	0	Y	0100	0001	10	11
304	4	0	Y	1001	1100	01	11	374	4	0	N	0100	1011	10	11	444	2	0	N	1000	0001	10	11
305	2	0	N	0001	1100	01	11	375	4	0	N	1000	1011	10	11	445	2	0	Y	0000	0001	10	11
306	2	0	Y	1110	1100	01	11	376	4	0	N	0000	1011	10	11	446	2	0	N	0111	1110	10	11
307	2	0	N	0110	1100	01	11	377	2	0	Y	0111	0011	10	11	447	2	0	N	0011	1110	10	11
308	2	0	Y	1010	1100	01	11	378	4	0	Y	1011	0011	10	11	448	2	0	N	0101	1110	10	11
309	2	0	N	0010	1100	01	11	379	2	0	Y	0011	0011	10	11	449	4	0	N	1001	1110	10	11
310	2	0	Y	1100	1100	01	11	380	2	0	Y	0101	0011	10	11	450	2	0	N	0001	1110	10	11
311	2	0	Y	0100	1100	01	11	381	4	0	Y	1001	0011	10	11	451	2	0	Y	1110	1110	10	11
312	2	0	Y	1000	1100	01	11	382	2	0	Y	0001	0011	10	11	452	2	0	N	0110	1110	10	11
313	2	0	Y	0000	1100	01	11	383	2	0	N	1110	0011	10	11	453	2	0	Y	1010	1110	10	11
314	2	0	N	0111	0100	01	11	384	2	0	N	0110	0011	10	11	454	2	0	N	0010	1110	10	11
315	2	0	Y	0101	0100	01	11	385	2	0	N	1010	0011	10	11	455	2	0	Y	1100	1110	10	11
316	2	0	N	1110	0100	01	11	386	2	0	Y	0010	0011	10	11	456	2	0	N	0100	1110	10	11



317	2	0	Y	0110	0100	01	11	387	2	0	N	1100	0011	10	11	457	2	0	Y	1000	1110	10	11
318	2	0	Y	1100	0100	01	11	388	2	0	N	0100	0011	10	11	458	2	0	N	0000	1110	10	11
319	2	0	Y	0100	0100	01	11	389	2	0	N	1000	0011	10	11	459	2	0	N	0111	0110	10	11
320	2	0	N	0111	1000	01	11	390	2	0	Y	0000	0011	10	11	460	2	0	N	1011	0110	10	11
321	4	0	N	1011	1000	01	11	391	4	0	N	0111	1101	10	11	461	2	0	N	0011	0110	10	11
322	2	0	N	0011	1000	01	11	392	4	0	N	0011	1101	10	11	462	2	0	N	0101	0110	10	11
323	2	0	N	0101	1000	01	11	393	4	0	N	0101	1101	10	11	463	4	0	N	1001	0110	10	11
324	4	0	Y	1001	1000	01	11	394	8	0	Y	1001	1101	10	11	464	2	0	N	0001	0110	10	11
325	2	0	N	0001	1000	01	11	395	4	0	N	0001	1101	10	11	465	2	0	N	1110	0110	10	11
326	2	0	Y	1110	1000	01	11	396	4	0	N	1110	1101	10	11	466	2	0	Y	0110	0110	10	11
327	2	0	N	0110	1000	01	11	397	4	0	N	0110	1101	10	11	467	2	0	N	1010	0110	10	11
328	2	0	Y	1010	1000	01	11	398	4	0	N	1010	1101	10	11	468	2	0	Y	0010	0110	10	11
329	2	0	Y	0010	1000	01	11	399	4	0	N	0010	1101	10	11	469	2	0	N	1100	0110	10	11
330	2	43	Y	1100	1000	01	11	400	4	0	Y	1100	1101	10	11	470	2	0	Y	0100	0110	10	11
331	2	0	Y	0100	1000	01	11	401	4	0	N	0100	1101	10	11	471	2	0	N	1000	0110	10	11
332	2	51	Y	1000	1000	01	11	402	4	0	Y	1000	1101	10	11	472	2	0	Y	0000	0110	10	11
333	2	0	Y	0000	1000	01	11	403	4	0	N	0000	1101	10	11	473	2	0	N	0111	1010	10	11
334	2	0	N	0111	0000	01	11	404	2	32	Y	0111	0101	10	11	474	2	0	N	0011	1010	10	11
335	4	0	N	1011	0000	01	11	405	4	0	N	1011	0101	10	11	475	2	0	Y	1110	1010	10	11
336	2	0	Y	0011	0000	01	11	406	2	0	Y	0011	0101	10	11	476	2	0	N	0110	1010	10	11
337	2	0	N	1101	0000	01	11	407	2	36	Y	0101	0101	10	11	477	2	0	Y	1010	1010	10	11
338	2	0	Y	0101	0000	01	11	408	4	0	N	1001	0101	10	11	478	2	0	Y	0010	1010	10	11
339	4	0	Y	1001	0000	01	11	409	2	0	Y	0001	0101	10	11	479	2	0	N	0111	0010	10	11
340	2	0	Y	0001	0000	01	11	410	2	0	N	1110	0101	10	11	480	4	0	N	1011	0010	10	11
341	2	0	N	1110	0000	01	11	411	2	0	N	0110	0101	10	11	481	2	0	Y	0011	0010	10	11
342	2	0	Y	0110	0000	01	11	412	2	0	N	1010	0101	10	11	482	2	0	N	1110	0010	10	11
343	2	0	Y	1010	0000	01	11	413	2	0	N	0010	0101	10	11	483	2	0	Y	0110	0010	10	11
344	2	0	Y	0010	0000	01	11	414	2	0	N	1100	0101	10	11	484	2	0	Y	1010	0010	10	11
345	2	0	Y	1100	0000	01	11	415	2	0	Y	0100	0101	10	11	485	2	0	Y	0010	0010	10	11
346	2	55	Y	0100	0000	01	11	416	2	0	N	1000	0101	10	11	486	2	0	N	0111	1100	10	11
347	2	0	Y	1000	0000	01	11	417	2	0	Y	0000	0101	10	11	487	2	0	N	0011	1100	10	11
348	2	57	Y	0000	0000	01	11	418	4	0	N	0111	1001	10	11	488	2	0	N	0101	1100	10	11
349	2	0	Y	0111	0111	10	11	419	4	30	Y	1011	1001	10	11	489	4	0	Y	1001	1100	10	11
350	4	0	N	1011	0111	10	11	420	4	0	Y	0011	1001	10	11	490	2	0	N	0001	1100	10	11

O - Piece Orientations

Nt - Notchable Piece Number

S - Used in Solid Sol

Pce	O	Nt	S	Bit	Codes	Pce	O	Nt	S	Bit	Codes	Pce	O	Nt	S	Bit	Codes						
---	-	---	-	-----	-----	---	-	---	-	-----	-----	---	-	---	-	-----	-----						
561	4	0	Y	0011	1011	00	11	631	2	0	N	0011	1110	00	11	701	2	22	Y	0010	0000	00	11
562	4	0	N	0101	1011	00	11	632	2	0	N	0101	1110	00	11	702	2	0	Y	1100	0000	00	11
563	8	0	Y	1001	1011	00	11	633	2	0	N	0001	1110	00	11	703	2	23	Y	0100	0000	00	11
564	4	0	Y	0001	1011	00	11	634	2	0	Y	1110	1110	00	11	704	2	0	Y	1000	0000	00	11
565	4	0	N	1110	1011	00	11	635	2	0	N	0110	1110	00	11	705	2	3	Y	0000	0000	00	11
566	4	0	N	0110	1011	00	11	636	2	0	Y	1010	1110	00	11	706	4	0	N	1101	0111	01	01
567	4	0	N	1010	1011	00	11	637	2	0	N	0010	1110	00	11	707	2	0	N	1110	0111	01	01
568	4	0	N	0010	1011	00	11	638	2	0	Y	1100	1110	00	11	708	2	0	N	1100	0111	01	01
569	4	0	N	1100	1011	00	11	639	2	0	N	0100	1110	00	11	709	4	0	N	1110	1011	01	01
570	4	0	N	0100	1011	00	11	640	2	0	Y	1000	1110	00	11	710	2	0	N	1110	0011	01	01
571	4	0	N	1000	1011	00	11	641	2	0	N	0000	1110	00	11	711	4	0	N	0111	1101	01	01
572	4	0	N	0000	1011	00	11	642	2	0	N	0111	0110	00	11	712	4	0	N	1110	1101	01	01
573	2	0	Y	0111	0011	00	11	643	2	0	N	0011	0110	00	11	713	4	0	N	0110	1101	01	01
574	2	0	Y	0011	0011	00	11	644	2	0	N	0101	0110	00	11	714	2	0	N	1110	0101	01	01
575	2	0	Y	0101	0011	00	11	645	2	0	N	1110	0110	00	11	715	4	0	N	1110	1001	01	01
576	4	0	Y	1001	0011	00	11	646	2	0	Y	0110	0110	00	11	716	2	0	N	1110	0001	01	01

577 2 0 Y 0001 0011 00 11	647 2 0 N 1010 0110 00 11	717 2 0 N 0111 1110 01 01
578 2 0 N 1110 0011 00 11	648 2 0 Y 0010 0110 00 11	718 2 0 N 0011 1110 01 01
579 2 0 N 0110 0011 00 11	649 2 0 N 1100 0110 00 11	719 4 0 N 1101 1110 01 01
580 2 0 N 1010 0011 00 11	650 2 0 Y 0100 0110 00 11	720 2 0 N 0101 1110 01 01
581 2 0 Y 0010 0011 00 11	651 2 0 N 0111 1010 00 11	721 4 0 N 1001 1110 01 01
582 2 0 N 1100 0011 00 11	652 2 0 N 0011 1010 00 11	722 2 0 N 0001 1110 01 01
583 2 0 N 0100 0011 00 11	653 2 0 Y 1110 1010 00 11	723 2 59 Y 1110 1110 01 01
584 2 0 N 1000 0011 00 11	654 2 0 N 0110 1010 00 11	724 2 0 N 0110 1110 01 01
585 2 0 Y 0000 0011 00 11	655 2 0 Y 1010 1010 00 11	725 2 37 Y 1010 1110 01 01
586 4 0 N 0111 1101 00 11	656 2 0 Y 0010 1010 00 11	726 2 0 N 0010 1110 01 01
587 4 0 N 0011 1101 00 11	657 2 0 N 0111 0010 00 11	727 2 0 Y 1100 1110 01 01
588 4 0 N 0101 1101 00 11	658 2 0 Y 0011 0010 00 11	728 2 0 N 0100 1110 01 01
589 4 0 N 0001 1101 00 11	659 2 0 N 1110 0010 00 11	729 2 0 Y 1000 1110 01 01
590 4 0 N 1110 1101 00 11	660 2 0 Y 0110 0010 00 11	730 2 0 N 0000 1110 01 01
591 4 0 N 0110 1101 00 11	661 2 0 Y 1010 0010 00 11	731 4 0 N 1101 0110 01 01
592 4 0 N 1010 1101 00 11	662 2 0 Y 0010 0010 00 11	732 2 0 N 1110 0110 01 01
593 4 0 N 0010 1101 00 11	663 2 0 N 0111 1100 00 11	733 2 0 N 1100 0110 01 01
594 4 0 Y 1100 1101 00 11	664 2 0 N 0011 1100 00 11	734 2 38 Y 1110 1010 01 01
595 4 0 N 0100 1101 00 11	665 2 0 N 0101 1100 00 11	735 2 0 N 1110 0010 01 01
596 4 0 Y 1000 1101 00 11	666 2 0 N 0001 1100 00 11	736 2 0 N 0111 1100 01 01
597 4 0 N 0000 1101 00 11	667 2 0 Y 1110 1100 00 11	737 2 0 Y 1110 1100 01 01
598 2 0 Y 0111 0101 00 11	668 2 0 N 0110 1100 00 11	738 2 0 N 0110 1100 01 01
599 2 0 Y 0101 0101 00 11	669 2 0 Y 1010 1100 00 11	739 2 0 N 1110 0100 01 01
600 2 0 N 1110 0101 00 11	670 2 0 N 0010 1100 00 11	740 2 0 Y 1110 1000 01 01
601 2 0 N 0110 0101 00 11	671 2 0 Y 1100 1100 00 11	741 2 0 N 1110 0000 01 01
602 2 0 N 1100 0101 00 11	672 2 0 Y 0100 1100 00 11	742 2 0 Y 0111 0111 10 01
603 2 0 Y 0100 0101 00 11	673 2 0 Y 1000 1100 00 11	743 2 0 Y 0011 0111 10 01
604 4 0 Y 0111 1001 00 11	674 2 0 Y 0000 1100 00 11	744 4 0 N 1101 0111 10 01
605 4 0 Y 0011 1001 00 11	675 2 0 N 0111 0100 00 11	745 2 0 Y 0101 0111 10 01
606 4 0 Y 0101 1001 00 11	676 2 0 Y 0101 0100 00 11	746 4 0 N 1001 0111 10 01
607 4 9 Y 1001 1001 00 11	677 2 0 N 1110 0100 00 11	747 2 0 Y 0001 0111 10 01
608 4 0 Y 0001 1001 00 11	678 2 0 Y 0110 0100 00 11	748 1 0 N 1110 0111 10 01
609 4 0 Y 1110 1001 00 11	679 2 0 Y 1100 0100 00 11	749 2 0 N 0110 0111 10 01
610 4 0 Y 0110 1001 00 11	680 2 0 Y 0100 0100 00 11	750 2 0 N 1010 0111 10 01
611 4 0 Y 1010 1001 00 11	681 2 0 Y 0111 1000 00 11	751 2 0 N 0010 0111 10 01
612 4 0 Y 0010 1001 00 11	682 2 0 Y 0011 1000 00 11	752 2 0 N 1100 0111 10 01
613 4 0 Y 1100 1001 00 11	683 2 0 Y 0101 1000 00 11	753 2 0 N 0100 0111 10 01
614 4 0 Y 0100 1001 00 11	684 2 0 Y 0001 1000 00 11	754 2 0 N 1000 0111 10 01
615 4 0 Y 1000 1001 00 11	685 2 14 Y 1110 1000 00 11	755 2 0 N 0000 0111 10 01
616 4 0 Y 0000 1001 00 11	686 2 0 Y 0110 1000 00 11	756 2 0 Y 0111 0101 10 01
617 2 15 Y 0111 0001 00 11	687 2 24 Y 1010 1000 00 11	757 2 0 N 0110 0101 10 01
618 2 6 Y 0011 0001 00 11	688 2 0 Y 0010 1000 00 11	758 1 0 N 0111 1110 10 01
619 2 25 Y 0101 0001 00 11	689 2 5 Y 1100 1000 00 11	759 2 0 N 0011 1110 10 01
620 4 0 Y 1001 0001 00 11	690 2 0 Y 0100 1000 00 11	760 2 0 N 0110 1110 10 01
621 2 17 Y 0001 0001 00 11	691 2 16 Y 1000 1000 00 11	761 2 0 N 0010 1110 10 01
622 2 0 Y 1110 0001 00 11	692 2 0 Y 0000 1000 00 11	762 2 0 N 0011 0110 10 01
623 2 0 Y 0110 0001 00 11	693 2 0 Y 0111 0000 00 11	763 1 0 Y 0110 0110 10 01
624 2 0 Y 1010 0001 00 11	694 2 0 Y 0011 0000 00 11	764 2 0 Y 0010 0110 10 01
625 2 0 Y 0010 0001 00 11	695 2 0 Y 0101 0000 00 11	765 4 0 N 1101 0111 00 01
626 2 0 Y 1100 0001 00 11	696 2 0 Y 1001 0000 00 11	766 2 0 N 1110 0111 00 01
627 2 0 Y 0100 0001 00 11	697 2 0 Y 0001 0000 00 11	767 2 0 N 1100 0111 00 01
628 2 0 Y 1000 0001 00 11	698 2 0 Y 1110 0000 00 11	768 4 0 N 1110 1011 00 01
629 2 0 Y 0000 0001 00 11	699 2 4 Y 0110 0000 00 11	769 2 0 N 1110 0011 00 01
630 2 0 N 0111 1110 00 11	700 2 0 Y 1010 0000 00 11	770 4 0 N 0111 1101 00 01

O - Piece Orientations

Nt - Notchable Piece Number

S - Used in Solid Sol

Table 3 - 2225 Piece Orientations

Ornt	Cas	Pce	N	Bit-Codes				Ornt	Cas	Pce	N	Bit-Codes				Ornt	Cas	Pce	N	Bit-Codes			
---	---	---	---	-----	-----	-----	-----	---	---	---	---	-----	-----	-----	-----	---	---	---	---	-----	-----	-----	-----
1		1	Y	1111	1111	11	11	71		40	N	0111	0011	11	11	141		142	N	0011	1111	10	
2	1	2	N	0111	1111	11	11	72		13	N	1110	1100	11	11	142	36	146	N	0111	0111	01	
3		2	N	1111	0111	11	11	73		40	N	1100	1110	11	11	143		451	N	0111	0111	11	
4		2	N	1111	1110	11	11	74	19	15	N	0101	0111	11	11	144		146	N	1110	1110	11	
5		2	N	1110	1111	11	11	75		65	N	0111	0101	11	11	145		451	N	1110	1110	10	
6	2	3	N	1011	1111	11	11	76		15	N	1110	1010	11	11	146	37	147	N	1011	0111	01	
7		3	N	1111	1011	11	11	77		65	N	1010	1110	11	11	147		147	N	0111	1011	11	
8		3	N	1111	1101	11	11	78	20	16	N	1001	0111	11	11	148		147	N	1110	1101	11	
9		3	N	1101	1111	11	11	79		76	N	0111	1001	11	11	149		147	N	1101	1110	10	
10	3	3	N	1111	1111	01	11	80		16	N	1110	1001	11	11	150	38	149	N	1101	0111	01	
11		3	N	1111	1111	11	01	81		76	N	1001	1110	11	11	151		350	N	0111	1101	11	
12		3	N	1111	1111	11	10	82	21	19	N	0110	0111	11	11	152		149	N	1110	1011	11	
13		3	N	1111	1111	10	11	83		99	N	0111	0110	11	11	153		350	N	1011	1110	10	
14	4	4	N	0011	1111	11	11	84		19	N	1110	0110	11	11	154	39	153	N	1110	0111	01	
15		4	N	1111	0011	11	11	85		99	N	0110	1110	11	11	155		446	N	0111	1110	11	
16		4	N	1111	1100	11	11	86	22	20	N	1010	0111	11	11	156		153	N	1110	0111	11	
17		4	N	1100	1111	11	11	87		97	N	0111	1010	11	11	157		446	N	0111	1110	10	
18	5	5	N	0101	1111	11	11	88		20	N	1110	0101	11	11	158	40	161	N	0111	1011	01	
19		5	N	1111	0101	11	11	89		97	N	0101	1110	11	11	159		396	N	1011	0111	11	
20		5	N	1111	1010	11	11	90	23	22	N	1100	0111	11	11	160		161	N	1101	1110	11	
21		5	N	1010	1111	11	11	91		96	N	0111	1100	11	11	161		396	N	1110	1101	10	
22	6	12	N	1011	0111	11	11	92		22	N	1110	0011	11	11	162	41	162	Y	1011	1011	01	
23		26	N	0111	1011	11	11	93		96	N	0011	1110	11	11	163		162	Y	1011	1011	11	
24		12	N	1110	1101	11	11	94	24	28	N	0011	1011	11	11	164		162	Y	1101	1101	11	
25		26	N	1101	1110	11	11	95		41	N	1011	0011	11	11	165		162	Y	1101	1101	10	
26	7	14	N	1101	0111	11	11	96		28	N	1101	1100	11	11	166	42	164	N	1101	1011	01	
27		53	N	0111	1101	11	11	97		41	N	1100	1101	11	11	167		364	N	1011	1101	11	
28		14	N	1110	1011	11	11	98	25	30	N	0101	1011	11	11	168		164	N	1101	1011	11	
29		53	N	1011	1110	11	11	99		60	N	1011	0101	11	11	169		364	N	1011	1101	10	
30	8	131	N	0111	1111	01	11	100		30	N	1101	1010	11	11	170	43	168	N	1110	1011	01	
31		131	N	1111	0111	11	01	101		60	N	1010	1101	11	11	171		391	N	1011	1110	11	
32		131	N	1111	1110	11	10	102	26	31	N	1001	1011	11	11	172		168	N	1101	0111	11	
33		131	N	1110	1111	10	11	103		57	N	1011	1001	11	11	173		391	N	0111	1101	10	
34	9	132	N	1011	1111	01	11	104		31	N	1101	1001	11	11	174	44	28	N	1111	0011	01	
35		132	N	1111	1011	11	01	105		57	N	1001	1101	11	11	175		41	N	0011	1111	11	
36		132	N	1111	1101	11	10	106	27	33	N	0110	1011	11	11	176		28	N	1100	1111	11	
37		132	N	1101	1111	10	11	107		59	N	1011	0110	11	11	177		41	N	1111	1100	10	
38	10	134	N	1101	1111	01	11	108		33	N	1101	0110	11	11	178	45	191	N	0111	1101	01	
39		134	N	1111	1101	11	01	109		59	N	0110	1101	11	11	179		369	N	1101	0111	11	
40		134	N	1111	1011	11	10	110	28	34	N	1010	1011	11	11	180		191	N	1011	1110	11	
41		134	N	1011	1111	10	11	111		56	N	1011	1010	11	11	181		369	N	1110	1011	10	
42	11	138	N	1110	1111	01	11	112		34	N	1101	0101	11	11	182	46	192	N	1011	1101	01	
43		138	N	1111	1110	11	01	113		56	N	0101	1101	11	11	183		192	N	1101	1011	11	
44		138	N	1111	0111	11	10	114	29	36	N	1100	1011	11	11	184		192	N	1011	1101	11	
45		138	N	0111	1111	10	11	115		55	N	1011	1100	11	11	185		192	N	1101	1011	10	
46	12	26	N	1111	0111	01	11	116		36	N	1101	0011	11	11	186	47	164	N	1101	1101	01	
47		12	N	0111	1111	11	01	117		55	N	0011	1101	11	11	187		364	N	1101	1101	11	
48		26	N	1110	1111	11	10	118	30	133	N	0011	1111	01	11	188		164	N	1011	1011	11	
49		12	N	1111	1110	10	11	119		133	N	1111	0011	11	01	189		364	N	1011	1011	10	
50	13	27	Y	1111	1011	01	11	120		133	N	1111	1100	11	10	190	48	197	N	1110	1101	01	
51		27	Y	1011	1111	11	01	121		133	N	1100	1111	10	11	191		363	N	1101	1110	11	
52		27	Y	1101	1111	11	10	122	31	135	N	0101	1111	01	11	192		197	N	1011	0111	11	
53		27	Y	1111	1101	10	11	123		135	N	1111	0101	11	01	193		363	N	0111	1011	10	
54	14	29	N	1111	1101	01	11	124		135	N	1111	1010	11	10	194	49	30	N	1111	0101	01	
55		54	N	1101	1111	11	01	125		135	N	1010	1111	10	11	195		60	N	0101	1111	11	
56		29	N	1011	1111	11	10	126	32	136	N	1001	1111	01	11	196		30	N	1010	1111	11	

57		54	N	1111	1011	10	11	127		136	N	1111	1001	11	01	197		60	N	1111	1010	10
58	15	14	N	1111	1110	01	11	128		136	N	1111	1001	11	10	198	50	31	N	1111	1001	01
59		53	N	1110	1111	11	01	129		136	N	1001	1111	10	11	199		57	N	1001	1111	11
60		14	N	0111	1111	11	10	130	33	139	N	0110	1111	01	11	200		31	N	1001	1111	11
61		53	N	1111	0111	10	11	131		139	N	1111	0110	11	01	201		57	N	1111	1001	10
62	16	7	N	0001	1111	11	11	132		139	N	1111	0110	11	10	202	51	242	N	0111	1110	01
63		7	N	1111	0001	11	11	133		139	N	0110	1111	10	11	203		355	N	1110	0111	11
64		7	N	1111	1000	11	11	134	34	140	N	1010	1111	01	11	204		242	N	0111	1110	11
65		7	N	1000	1111	11	11	135		140	N	1111	1010	11	01	205		355	N	1110	0111	10
66	17	9	N	0010	1111	11	11	136		140	N	1111	0101	11	10	206	52	243	N	1011	1110	01
67		9	N	1111	0010	11	11	137		140	N	0101	1111	10	11	207		243	N	1110	1011	11
68		9	N	1111	0100	11	11	138	35	142	N	1100	1111	01	11	208		243	N	0111	1101	11
69		9	N	0100	1111	11	11	139		142	N	1111	1100	11	01	209		243	N	1101	0111	10
70	18	13	N	0011	0111	11	11	140		142	N	1111	0011	11	10	210	53	149	N	1101	1110	01

Ornt - Orientation Number

Cas - Case Number

Pce - Piece Number

N

Ornt	Cas	Pce	N	Bit-Codes	Ornt	Cas	Pce	N	Bit-Codes	Ornt	Cas	Pce	N	Bit-Codes
281		57	N	1111 1111 00 10	351		144	N	1111 1000 11 01	421		373	N	1100 1011 10
282	71	17	N	0001 0111 11 11	352		144	N	1111 0001 11 10	422	106	194	N	0101 1101 01
283		86	N	0111 0001 11 11	353		144	N	0001 1111 10 11	423		371	N	1101 0101 11
284		17	N	1110 1000 11 11	354	89	148	N	0011 0111 01 11	424		194	N	1011 1010 11
285		86	N	1000 1110 11 11	355		455	N	0111 0011 11 01	425		371	N	1010 1011 10
286	72	21	N	0010 0111 11 11	356		148	N	1110 1100 11 10	426	107	195	N	1001 1101 01
287		101	N	0111 0010 11 11	357		455	N	1100 1110 10 11	427		367	N	1101 1001 11
288		21	N	1110 0100 11 11	358	90	150	N	0101 0111 01 11	428		195	N	1011 1001 11
289		101	N	0100 1110 11 11	359		453	N	0111 0101 11 01	429		367	N	1001 1011 10
290	73	23	N	0100 0111 11 11	360		150	N	1110 1010 11 10	430	108	198	N	0110 1101 01
291		100	N	0111 0100 11 11	361		453	N	1010 1110 10 11	431		370	N	1101 0110 11
292		23	N	1110 0010 11 11	362	91	151	N	1001 0111 01 11	432		198	N	1011 0110 11
293		100	N	0010 1110 11 11	363		449	N	0111 1001 11 01	433		370	N	0110 1011 10
294	74	24	N	1000 0111 11 11	364		151	N	1110 1001 11 10	434	109	199	N	1010 1101 01
295		98	N	0111 1000 11 11	365		449	N	1001 1110 10 11	435		366	N	1101 1010 11
296		24	N	1110 0001 11 11	366	92	154	N	0110 0111 01 11	436		199	N	1011 0101 11
297		98	N	0001 1110 11 11	367		452	N	0111 0110 11 01	437		366	N	0101 1011 10
298	75	32	N	0001 1011 11 11	368		154	N	1110 0110 11 10	438	110	201	N	1100 1101 01
299		63	N	1011 0001 11 11	369		452	N	0110 1110 10 11	439		365	N	1101 1100 11
300		32	N	1101 1000 11 11	370	93	155	N	1010 0111 01 11	440		201	N	1011 0011 11
301		63	N	1000 1101 11 11	371		448	N	0111 1010 11 01	441		365	N	0011 1011 10
302	76	35	N	0010 1011 11 11	372		155	N	1110 0101 11 10	442	111	205	N	0111 0101 01
303		62	N	1011 0010 11 11	373		448	N	0101 1110 10 11	443		475	N	0101 0111 11
304		35	N	1101 0100 11 11	374	94	157	N	1100 0111 01 11	444		205	N	1010 1110 11
305		62	N	0100 1101 11 11	375		447	N	0111 1100 11 01	445		475	N	1110 1010 10
306	77	37	N	0100 1011 11 11	376		157	N	1110 0011 11 10	446	112	206	N	1101 0101 01
307		61	N	1011 0100 11 11	377		447	N	0011 1110 10 11	447		405	N	0101 1101 11
308		37	N	1101 0010 11 11	378	95	163	N	0011 1011 01 11	448		206	N	1010 1011 11
309		61	N	0010 1101 11 11	379		400	N	1011 0011 11 01	449		405	N	1011 1010 10
310	78	38	N	1000 1011 11 11	380		163	N	1101 1100 11 10	450	113	208	N	1110 0101 01
311		58	N	1011 1000 11 11	381		400	N	1100 1101 10 11	451		473	N	0101 1110 11
312		38	N	1101 0001 11 11	382	96	165	N	0101 1011 01 11	452		208	N	1010 0111 11
313		58	N	0001 1101 11 11	383		398	N	1011 0101 11 01	453		473	N	0111 1010 10
314	79	43	N	0101 0011 11 11	384		165	N	1101 1010 11 10	454	114	212	N	0111 1001 01
315		66	N	0011 0101 11 11	385		398	N	1010 1101 10 11	455		424	N	1001 0111 11
316		43	N	1100 1010 11 11	386	97	166	N	1001 1011 01 11	456		212	N	1001 1110 11

317		66	N	1010	1100	11	11	387		394	N	1011	1001	11	01	457		424	N	1110	1001	10
318	80	44	N	1001	0011	11	11	388		166	N	1101	1001	11	10	458	115	213	N	1011	1001	01
319		77	N	0011	1001	11	11	389		394	N	1001	1101	10	11	459		213	N	1001	1011	11
320		44	N	1100	1001	11	11	390	98	169	N	0110	1011	01	11	460		213	N	1001	1101	11
321		77	N	1001	1100	11	11	391		397	N	1011	0110	11	01	461		213	N	1101	1001	10
322	81	46	N	0110	0011	11	11	392		169	N	1101	0110	11	10	462	116	215	Y	1101	1001	01
323		103	N	0011	0110	11	11	393		397	N	0110	1101	10	11	463		419	Y	1001	1101	11
324		46	N	1100	0110	11	11	394	99	170	N	1010	1011	01	11	464		215	Y	1001	1011	11
325		103	N	0110	1100	11	11	395		393	N	1011	1010	11	01	465		419	Y	1011	1001	10
326	82	47	N	1010	0011	11	11	396		170	N	1101	0101	11	10	466	117	219	N	1110	1001	01
327		110	N	0011	1010	11	11	397		393	N	0101	1101	10	11	467		418	N	1001	1110	11
328		47	N	1100	0101	11	11	398	100	172	N	1100	1011	01	11	468		219	N	1001	0111	11
329		110	N	0101	1100	11	11	399		392	N	1011	1100	11	01	469		418	N	0111	1001	10
330	83	68	N	1001	0101	11	11	400		172	N	1101	0011	11	10	470	118	32	N	1111	0001	01
331		78	N	0101	1001	11	11	401		392	N	0011	1101	10	11	471		63	N	0001	1111	11
332		68	N	1010	1001	11	11	402	101	176	Y	0111	0011	01	11	472		32	N	1000	1111	11
333		78	N	1001	1010	11	11	403		491	Y	0011	0111	11	01	473		63	N	1111	1000	10
334	84	70	N	0110	0101	11	11	404		176	Y	1100	1110	11	10	474	119	244	N	0011	1110	01
335		104	N	0101	0110	11	11	405		491	Y	1110	1100	10	11	475		359	N	1110	0011	11
336		70	N	1010	0110	11	11	406	102	177	N	1011	0011	01	11	476		244	N	0111	1100	11
337		104	N	0110	1010	11	11	407		177	N	0011	1011	11	01	477		359	N	1100	0111	10
338	85	137	N	0001	1111	01	11	408		177	N	1100	1101	11	10	478	120	245	N	0101	1110	01
339		137	N	1111	0001	11	01	409		177	N	1101	1100	10	11	479		357	N	1110	0101	11
340		137	N	1111	1000	11	10	410	103	179	N	1101	0011	01	11	480		245	N	0111	1010	11
341		137	N	1000	1111	10	11	411		378	N	0011	1101	11	01	481		357	N	1010	0111	10
342	86	141	N	0010	1111	01	11	412		179	N	1100	1011	11	10	482	121	246	N	1001	1110	01
343		141	N	1111	0010	11	01	413		378	N	1011	1100	10	11	483		353	N	1110	1001	11
344		141	N	1111	0100	11	10	414	104	183	N	1110	0011	01	11	484		246	N	0111	1001	11
345		141	N	0100	1111	10	11	415		486	N	0011	1110	11	01	485		353	N	1001	0111	10
346	87	143	N	0100	1111	01	11	416		183	N	1100	0111	11	10	486	122	249	N	0110	1110	01
347		143	N	1111	0100	11	01	417		486	N	0111	1100	10	11	487		356	N	1110	0110	11
348		143	N	1111	0010	11	10	418	105	193	N	0011	1101	01	11	488		249	N	0111	0110	11
349		143	N	0010	1111	10	11	419		373	N	1101	0011	11	01	489		356	N	0110	0111	10
350	88	144	N	1000	1111	01	11	420		193	N	1011	1100	11	10	490	123	250	N	1010	1110	01

Ornt - Orientation Number

Cas - Case Number

Pce - Piece Number

N

Ornt	Cas	Pce	N	Bit-Codes	Ornt	Cas	Pce	N	Bit-Codes	Ornt	Cas	Pce	N	Bit-Codes
561		540	N	1100 1111 00 11	631		711	N	0111 1101 01 01	701		565	N	0111 1111 00
562	141	541	N	0101 1111 00 11	632		706	N	1110 1011 10 10	702	176	212	N	1111 0111 00
563		541	N	1111 0101 11 00	633		711	N	1011 1110 10 10	703		424	N	0111 1111 01
564		541	N	1111 1010 11 00	634	159	707	N	1110 0111 01 01	704		212	N	1110 1111 10
565		541	N	1010 1111 00 11	635		717	N	0111 1110 01 01	705		424	N	1111 1110 00
566	142	547	N	0111 0111 00 11	636		707	N	1110 0111 10 10	706	177	213	N	1111 1011 00
567		634	N	0111 0111 11 00	637		717	N	0111 1110 10 10	707		213	N	1011 1111 01
568		547	N	1110 1110 11 00	638	160	709	N	1110 1011 01 01	708		213	N	1101 1111 10
569		634	N	1110 1110 00 11	639		709	N	1011 1110 01 01	709		213	N	1111 1101 00
570	143	449	N	1011 0111 00 11	640		709	N	1101 0111 10 10	710	178	215	Y	1111 1101 00
571		151	N	0111 1011 11 00	641		709	N	0111 1101 10 10	711		419	Y	1101 1111 01
572		449	N	1110 1101 11 00	642	161	712	N	1110 1101 01 01	712		215	Y	1011 1111 10
573		151	N	1101 1110 00 11	643		719	N	1101 1110 01 01	713		419	Y	1111 1011 00
574	144	246	N	1101 0111 00 11	644		712	N	1011 0111 10 10	714	179	219	N	1111 1110 00
575		353	N	0111 1101 11 00	645		719	N	0111 1011 10 10	715		418	N	1110 1111 01
576		246	N	1110 1011 11 00	646	162	201	N	0011 1111 10 01	716		219	N	0111 1111 10

577	353	N	1011	1110	00	11	647	365	N	1111	0011	01	10	717	418	N	1111	0111	00		
578	145	552	N	1110	0111	00	11	648	201	N	1111	1100	10	01	718	180	25	N	0000	0111	11
579	630	N	0111	1110	11	00	649	365	N	1100	1111	01	10	719	102	N	0111	0000	11		
580	552	N	1110	0111	11	00	650	163	199	N	0101	1111	10	01	720	25	N	1110	0000	11	
581	630	N	0111	1110	00	11	651	366	N	1111	0101	01	10	721	102	N	0000	1110	11		
582	146	560	N	0111	1011	00	11	652	199	N	1111	1010	10	01	722	181	39	N	0000	1011	11
583	590	N	1011	0111	11	00	653	366	N	1010	1111	01	10	723	64	N	1011	0000	11		
584	560	N	1101	1110	11	00	654	164	195	N	1001	1111	10	01	724	39	N	1101	0000	11	
585	590	N	1110	1101	00	11	655	367	N	1111	1001	01	10	725	64	N	0000	1101	11		
586	147	394	N	1011	1011	00	11	656	195	N	1111	1001	10	01	726	182	45	N	0001	0011	11
587	166	N	1011	1011	11	00	657	367	N	1001	1111	01	10	727	87	N	0011	0001	11		
588	394	N	1101	1101	11	00	658	165	198	N	0110	1111	10	01	728	45	N	1100	1000	11	
589	166	N	1101	1101	00	11	659	370	N	1111	0110	01	10	729	87	N	1000	1100	11		
590	148	195	N	1101	1011	00	11	660	198	N	1111	0110	10	01	730	183	48	N	0010	0011	11
591	367	N	1011	1101	11	00	661	370	N	0110	1111	01	10	731	116	N	0011	0010	11		
592	195	N	1101	1011	11	00	662	166	194	N	1010	1111	10	01	732	48	N	1100	0100	11	
593	367	N	1011	1101	00	11	663	371	N	1111	1010	01	10	733	116	N	0100	1100	11		
594	149	565	N	1110	1011	00	11	664	194	N	1111	0101	10	01	734	184	50	N	0100	0011	11
595	586	N	1011	1110	11	00	665	371	N	0101	1111	01	10	735	123	N	0011	0100	11		
596	565	N	1101	0111	11	00	666	167	193	N	1100	1111	10	01	736	50	N	1100	0010	11	
597	586	N	0111	1101	00	11	667	373	N	1111	1100	01	10	737	123	N	0010	1100	11		
598	150	77	N	1111	0011	00	11	668	193	N	1111	0011	10	01	738	185	51	N	1000	0011	11
599	44	N	0011	1111	11	00	669	373	N	0011	1111	01	10	739	122	N	0011	1000	11		
600	77	N	1100	1111	11	00	670	168	742	N	0111	0111	10	01	740	51	N	1100	0001	11	
601	44	N	1111	1100	00	11	671	790	N	0111	0111	01	10	741	122	N	0001	1100	11		
602	151	78	N	1111	0101	00	11	672	742	N	1110	1110	10	01	742	186	69	N	0001	0101	11
603	68	N	0101	1111	11	00	673	790	N	1110	1110	01	10	743	88	N	0101	0001	11		
604	78	N	1010	1111	11	00	674	169	711	N	1011	0111	10	01	744	69	N	1010	1000	11	
605	68	N	1111	1010	00	11	675	706	N	0111	1011	01	10	745	88	N	1000	1010	11		
606	152	400	N	0011	1111	01	01	676	711	N	1110	1101	10	01	746	187	72	N	0010	0101	11
607	163	N	1111	0011	01	01	677	706	N	1101	1110	01	10	747	114	N	0101	0010	11		
608	400	N	1111	1100	10	10	678	170	744	N	1101	0111	10	01	748	72	N	1010	0100	11	
609	163	N	1100	1111	10	10	679	744	N	0111	1101	01	10	749	114	N	0100	1010	11		
610	153	398	N	0101	1111	01	01	680	744	N	1110	1011	10	01	750	188	73	N	0100	0101	11
611	165	N	1111	0101	01	01	681	744	N	1011	1110	01	10	751	113	N	0101	0100	11		
612	398	N	1111	1010	10	10	682	171	712	N	0111	1101	10	01	752	73	N	1010	0010	11	
613	165	N	1010	1111	10	10	683	719	N	1101	0111	01	10	753	113	N	0010	1010	11		
614	154	394	N	1001	1111	01	01	684	712	N	1011	1110	10	01	754	189	74	N	1000	0101	11
615	166	N	1111	1001	01	01	685	719	N	1110	1011	01	10	755	112	N	0101	1000	11		
616	394	N	1111	1001	10	10	686	172	590	N	0111	1111	00	01	756	74	N	1010	0001	11	
617	166	N	1001	1111	10	10	687	560	N	1111	0111	01	00	757	112	N	0001	1010	11		
618	155	397	N	0110	1111	01	01	688	590	N	1111	1110	10	00	758	190	80	N	0001	1001	11
619	169	N	1111	0110	01	01	689	560	N	1110	1111	00	10	759	84	N	1001	0001	11		
620	397	N	1111	0110	10	10	690	173	166	N	1011	1111	00	01	760	80	N	1001	1000	11	
621	169	N	0110	1111	10	10	691	394	N	1111	1011	01	00	761	84	N	1000	1001	11		
622	156	393	N	1010	1111	01	01	692	166	N	1111	1101	10	00	762	191	82	N	0010	1001	11
623	170	N	1111	1010	01	01	693	394	N	1101	1111	00	10	763	83	N	1001	0010	11		
624	393	N	1111	0101	10	10	694	174	367	N	1101	1111	00	01	764	82	N	1001	0100	11	
625	170	N	0101	1111	10	10	695	195	N	1111	1101	01	00	765	83	N	0100	1001	11		
626	157	392	N	1100	1111	01	01	696	367	N	1111	1011	10	00	766	192	90	N	0110	0001	11
627	172	N	1111	1100	01	01	697	195	N	1011	1111	00	10	767	105	N	0001	0110	11		
628	392	N	1111	0011	10	10	698	175	586	N	1110	1111	00	01	768	90	N	1000	0110	11	
629	172	N	0011	1111	10	10	699	565	N	1111	1110	01	00	769	105	N	0110	1000	11		
630	158	706	N	1101	0111	01	01	700	586	N	1111	0111	10	00	770	193	107	N	0010	0110	11

Ornt - Orientation Number

Cas - Case Number

Pce - Piece Number

N

Ornt	Cas	Pce	N	Bit-Codes				Ornt	Cas	Pce	N	Bit-Codes				Ornt	Cas	Pce	N	Bit-Codes			
---	---	---	-	---	---	---	---	---	---	---	-	---	---	---	---	---	---	---	-	---	---	---	---
841		374	N	0100	1011	10	11	911		358	N	1110	0100	11	01	981		499	N	0111	0100	10	
842	211	202	N	0100	1101	01	11	912		253	N	0111	0010	11	10	982	246	302	N	0011	1100	01	
843		372	N	1101	0100	11	01	913		358	N	0010	0111	10	11	983		387	N	1100	0011	11	
844		202	N	1011	0010	11	10	914	229	254	N	1000	1110	01	11	984		302	N	0011	1100	11	
845		372	N	0010	1011	10	11	915		354	N	1110	1000	11	01	985		387	N	1100	0011	10	
846	212	203	N	1000	1101	01	11	916		254	N	0111	0001	11	10	986	247	303	N	0101	1100	01	
847		368	N	1101	1000	11	01	917		354	N	0001	0111	10	11	987		385	N	1100	0101	11	
848		203	N	1011	0001	11	10	918	230	258	N	0011	0110	01	11	988		303	N	0011	1010	11	
849		368	N	0001	1011	10	11	919		469	N	0110	0011	11	01	989		385	N	1010	0011	10	
850	213	207	N	0101	0101	01	11	920		258	N	0110	1100	11	10	990	248	304	N	1001	1100	01	
851		477	N	0101	0101	11	01	921		469	N	1100	0110	10	11	991		381	N	1100	1001	11	
852		207	N	1010	1010	11	10	922	231	260	N	0101	0110	01	11	992		304	N	0011	1001	11	
853		477	N	1010	1010	10	11	923		467	N	0110	0101	11	01	993		381	N	1001	0011	10	
854	214	209	N	0110	0101	01	11	924		260	N	0110	1010	11	10	994	249	307	N	0110	1100	01	
855		476	N	0101	0110	11	01	925		467	N	1010	0110	10	11	995		384	N	1100	0110	11	
856		209	N	1010	0110	11	10	926	232	261	N	1001	0110	01	11	996		307	N	0011	0110	11	
857		476	N	0110	1010	10	11	927		463	N	0110	1001	11	01	997		384	N	0110	0011	10	
858	215	210	N	1100	0101	01	11	928		261	N	0110	1001	11	10	998	250	308	N	1010	1100	01	
859		474	N	0101	1100	11	01	929		463	N	1001	0110	10	11	999		380	N	1100	1010	11	
860		210	N	1010	0011	11	10	930	233	264	N	0110	0110	01	11	1000		308	N	0011	0101	11	
861		474	N	0011	1010	10	11	931		466	N	0110	0110	11	01	1001		380	N	0101	0011	10	
862	216	214	N	0011	1001	01	11	932		264	N	0110	0110	11	10	1002	251	310	N	1100	1100	01	
863		428	N	1001	0011	11	01	933		466	N	0110	0110	10	11	1003		379	N	1100	1100	11	
864		214	N	1001	1100	11	10	934	234	265	N	1010	0110	01	11	1004		310	N	0011	0011	11	
865		428	N	1100	1001	10	11	935		462	N	0110	1010	11	01	1005		379	N	0011	0011	10	
866	217	216	N	0101	1001	01	11	936		265	N	0110	0101	11	10	1006	252	314	N	0111	0100	01	
867		426	N	1001	0101	11	01	937		462	N	0101	0110	10	11	1007		482	N	0100	0111	11	
868		216	N	1001	1010	11	10	938	235	267	N	1100	0110	01	11	1008		314	N	0010	1110	11	
869		426	N	1010	1001	10	11	939		461	N	0110	1100	11	01	1009		482	N	1110	0010	10	
870	218	217	Y	1001	1001	01	11	940		267	N	0110	0011	11	10	1010	253	288	N	1101	0100	01	
871		422	Y	1001	1001	11	01	941		461	N	0011	0110	10	11	1011		480	N	0100	1101	11	
872		217	Y	1001	1001	11	10	942	236	273	N	0011	1010	01	11	1012		288	N	0010	1011	11	
873		422	Y	1001	1001	10	11	943		414	N	1010	0011	11	01	1013		480	N	1011	0010	10	
874	219	220	N	0110	1001	01	11	944		273	N	0101	1100	11	10	1014	254	316	N	1110	0100	01	
875		425	N	1001	0110	11	01	945		414	N	1100	0101	10	11	1015		479	N	0100	1110	11	
876		220	N	1001	0110	11	10	946	237	274	N	0101	1010	01	11	1016		316	N	0010	0111	11	
877		425	N	0110	1001	10	11	947		412	N	1010	0101	11	01	1017		479	N	0111	0010	10	
878	220	221	N	1010	1001	01	11	948		274	N	0101	1010	11	10	1018	255	320	N	0111	1000	01	
879		421	N	1001	1010	11	01	949		412	N	1010	0101	10	11	1019		438	N	1000	0111	11	
880		221	N	1001	0101	11	10	950	238	275	N	1001	1010	01	11	1020		320	N	0001	1110	11	
881		421	N	0101	1001	10	11	951		408	N	1010	1001	11	01	1021		438	N	1110	0001	10	
882	221	223	N	1100	1001	01	11	952		275	N	0101	1001	11	10	1022	256	321	N	1011	1000	01	
883		420	N	1001	1100	11	01	953		408	N	1001	0101	10	11	1023		321	N	1000	1011	11	
884		223	N	1001	0011	11	10	954	239	278	N	0110	1010	01	11	1024		321	N	0001	1101	11	
885		420	N	0011	1001	10	11	955		411	N	1010	0110	11	01	1025		321	N	1101	0001	10	
886	222	227	N	0111	0001	01	11	956		278	N	0101	0110	11	10	1026	257	230	N	1101	1000	01	
887		517	N	0001	0111	11	01	957		411	N	0110	0101	10	11	1027		433	N	1000	1101	11	
888		227	N	1000	1110	11	10	958	240	279	Y	1010	1010	01	11	1028		230	N	0001	1011	11	
889		517	N	1110	1000	10	11	959		407	Y	1010	1010	11	01	1029		433	N	1011	0001	10	
890	223	228	N	1011	0001	01	11	960		279	Y	0101	0101	11	10	1030	258	326	N	1110	1000	01	
891		228	N	0001	1011	11	01	961		407	Y	0101	0101	10	11	1031		432	N	1000	1110	11	
892		228	N	1000	1101	11	10	962	241	281	N	1100	1010	01	11	1032		326	N	0001	0111	11	
893		228	N	1101	1000	10	11	963		406	N	1010	1100	11	01	1033		432	N	0111	0001	10	
894	224	230	N	1101	0001	01	11	964		281	N	0101	0011	11	10	1034	259	39	N	1111	0000	01	
895		433	N	0001	1101	11	01	965		406	N	0011	0101	10	11	1035		64	N	0000	1111	11	
896		230	N	1000	1011	11	10	966	242	285	N	0111	0010	01	11	1036		39	N	0000	1111	11	

897		433	N	1011	1000	10	11	967		504	N	0010	0111	11	01	1037		64	N	1111	0000	10
898	225	234	N	1110	0001	01	11	968		285	N	0100	1110	11	10	1038	260	543	N	0001	1111	00
899		512	N	0001	1110	11	01	969		504	N	1110	0100	10	11	1039		543	N	1111	0001	11
900		234	N	1000	0111	11	10	970	243	286	N	1011	0010	01	11	1040		543	N	1111	1000	11
901		512	N	0111	1000	10	11	971		286	N	0010	1011	11	01	1041		543	N	1000	1111	00
902	226	247	N	0001	1110	01	11	972		286	N	0100	1101	11	10	1042	261	545	N	0010	1111	00
903		361	N	1110	0001	11	01	973		286	N	1101	0100	10	11	1043		545	N	1111	0010	11
904		247	N	0111	1000	11	10	974	244	288	N	1101	0010	01	11	1044		545	N	1111	0100	11
905		361	N	1000	0111	10	11	975		480	N	0010	1101	11	01	1045		545	N	0100	1111	00
906	227	251	N	0010	1110	01	11	976		288	N	0100	1011	11	10	1046	262	548	N	0011	0111	00
907		360	N	1110	0010	11	01	977		480	N	1011	0100	10	11	1047		638	N	0111	0011	11
908		251	N	0111	0100	11	10	978	245	292	N	1110	0010	01	11	1048		548	N	1110	1100	11
909		360	N	0100	0111	10	11	979		499	N	0010	1110	11	01	1049		638	N	1100	1110	00
910	228	253	N	0100	1110	01	11	980		292	N	0100	0111	11	10	1050	263	549	N	0101	0111	00

Ornt - Orientation Number

Cas - Case Number

Pce - Piece Number

N

Ornt	Cas	Pce	N	Bit-Codes				Ornt	Cas	Pce	N	Bit-Codes				Ornt	Cas	Pce	N	Bit-Codes			
----	---	---	-	-----	-----	-----	-----	----	---	---	-	-----	-----	-----	-----	----	---	---	-	-----	-----	-----	-----
1121		651	N	0111	1010	00	11	1191		737	N	1110	1100	01	01	1261		563	N	1001	1111	00	
1122	281	604	N	0111	1001	00	11	1192		727	N	0111	0011	10	10	1262	316	591	N	0110	1111	00	
1123		609	N	1001	0111	11	00	1193		737	N	0011	0111	10	10	1263		566	N	1111	0110	01	
1124		604	N	1001	1110	11	00	1194	299	203	N	0001	1111	10	01	1264		591	N	1111	0110	10	
1125		609	N	1110	1001	00	11	1195		368	N	1111	0001	01	10	1265		566	N	0110	1111	00	
1126	282	422	Y	1011	1001	00	11	1196		203	N	1111	1000	10	01	1266	317	588	N	1010	1111	00	
1127		217	Y	1001	1011	11	00	1197		368	N	1000	1111	01	10	1267		567	N	1111	1010	01	
1128		422	Y	1001	1101	11	00	1198	300	202	N	0010	1111	10	01	1268		588	N	1111	0101	10	
1129		217	Y	1101	1001	00	11	1199		372	N	1111	0010	01	10	1269		567	N	0101	1111	00	
1130	283	80	N	1111	0001	00	11	1200		202	N	1111	0100	10	01	1270	318	587	N	1100	1111	00	
1131		84	N	0001	1111	11	00	1201		372	N	0100	1111	01	10	1271		569	N	1111	1100	01	
1132		80	N	1000	1111	11	00	1202	301	200	N	0100	1111	10	01	1272		587	N	1111	0011	10	
1133		84	N	1111	1000	00	11	1203		374	N	1111	0100	01	10	1273		569	N	0011	1111	00	
1134	284	642	N	0111	0110	00	11	1204		200	N	1111	0010	10	01	1274	319	765	N	1101	0111	00	
1135		645	N	0110	0111	11	00	1205		374	N	0010	1111	01	10	1275		746	N	0111	1101	01	
1136		642	N	0110	1110	11	00	1206	302	196	N	1000	1111	10	01	1276		765	N	1110	1011	10	
1137		645	N	1110	0110	00	11	1207		375	N	1111	1000	01	10	1277		746	N	1011	1110	00	
1138	285	463	N	1011	0110	00	11	1208		196	N	1111	0001	10	01	1278	320	766	N	1110	0111	00	
1139		261	N	0110	1011	11	00	1209		375	N	0001	1111	01	10	1279		825	N	0111	1110	01	
1140		463	N	0110	1101	11	00	1210	303	743	N	0011	0111	10	01	1280		766	N	1110	0111	10	
1141		261	N	1101	0110	00	11	1211		796	N	0111	0011	01	10	1281		825	N	0111	1110	00	
1142	286	82	N	1111	0010	00	11	1212		743	N	1110	1100	10	01	1282	321	768	N	1110	1011	00	
1143		83	N	0010	1111	11	00	1213		796	N	1100	1110	01	10	1283		768	N	1011	1110	01	
1144		82	N	0100	1111	11	00	1214	304	745	N	0101	0111	10	01	1284		768	N	1101	0111	10	
1145		83	N	1111	0100	00	11	1215		798	N	0111	0101	01	10	1285		768	N	0111	1101	00	
1146	287	402	N	0001	1111	01	01	1216		745	N	1110	1010	10	01	1286	322	214	N	1111	0011	00	
1147		167	N	1111	0001	01	01	1217		798	N	1010	1110	01	10	1287		428	N	0011	1111	01	
1148		402	N	1111	1000	10	10	1218	305	746	N	1001	0111	10	01	1288		214	N	1100	1111	10	
1149		167	N	1000	1111	10	10	1219		765	N	0111	1001	01	10	1289		428	N	1111	1100	00	
1150	288	401	N	0010	1111	01	01	1220		746	N	1110	1001	10	01	1290	323	770	N	0111	1101	00	
1151		171	N	1111	0010	01	01	1221		765	N	1001	1110	01	10	1291		817	N	1101	0111	01	
1152		401	N	1111	0100	10	10	1222	306	749	N	0110	0111	10	01	1292		770	N	1011	1110	10	
1153		171	N	0100	1111	10	10	1223		804	N	0111	0110	01	10	1293		817	N	1110	1011	00	
1154	289	399	N	0100	1111	01	01	1224		749	N	1110	0110	10	01	1294	324	770	N	1110	1101	00	
1155		173	N	1111	0100	01	01	1225		804	N	0110	1110	01	10	1295		817	N	1101	1110	01	
1156		399	N	1111	0010	10	10	1226	307	750	N	1010	0111	10	01	1296		770	N	1011	0111	10	



1157		173	N	0010	1111	10	10	1227		802	N	0111	1010	01	10	1297		817	N	0111	1011	00
1158	290	395	N	1000	1111	01	01	1228		750	N	1110	0101	10	01	1298	325	216	N	1111	0101	00
1159		174	N	1111	1000	01	01	1229		802	N	0101	1110	01	10	1299		426	N	0101	1111	01
1160		395	N	1111	0001	10	10	1230	308	752	N	1100	0111	10	01	1300		216	N	1010	1111	10
1161		174	N	0001	1111	10	10	1231		801	N	0111	1100	01	10	1301		426	N	1111	1010	00
1162	291	708	N	1100	0111	01	01	1232		752	N	1110	0011	10	01	1302	326	217	Y	1111	1001	00
1163		736	N	0111	1100	01	01	1233		801	N	0011	1110	01	10	1303		422	Y	1001	1111	01
1164		708	N	1110	0011	10	10	1234	309	713	N	0110	1101	10	01	1304		217	Y	1001	1111	10
1165		736	N	0011	1110	10	10	1235		731	N	1101	0110	01	10	1305		422	Y	1111	1001	00
1166	292	710	N	1110	0011	01	01	1236		713	N	1011	0110	10	01	1306	327	775	N	0111	1110	00
1167		718	N	0011	1110	01	01	1237		731	N	0110	1011	01	10	1307		813	N	1110	0111	01
1168		710	N	1100	0111	10	10	1238	310	756	N	0111	0101	10	01	1308		775	N	0111	1110	10
1169		718	N	0111	1100	10	10	1239		791	N	0101	0111	01	10	1309		813	N	1110	0111	00
1170	293	713	N	0110	1101	01	01	1240		756	N	1010	1110	10	01	1310	328	715	N	1011	1110	00
1171		731	N	1101	0110	01	01	1241		791	N	1110	1010	01	10	1311		721	N	1110	1011	01
1172		713	N	1011	0110	10	10	1242	311	759	N	0011	1110	10	01	1312		715	N	0111	1101	10
1173		731	N	0110	1011	10	10	1243		794	N	1110	0011	01	10	1313		721	N	1101	0111	00
1174	294	714	N	1110	0101	01	01	1244		759	N	0111	1100	10	01	1314	329	777	N	1110	1110	00
1175		720	N	0101	1110	01	01	1245		794	N	1100	0111	01	10	1315		811	N	1110	1110	01
1176		714	N	1010	0111	10	10	1246	312	760	N	0110	1110	10	01	1316		777	N	0111	0111	10
1177		720	N	0111	1010	10	10	1247		793	N	1110	0110	01	10	1317		811	N	0111	0111	00
1178	295	715	N	1110	1001	01	01	1248		760	N	0111	0110	10	01	1318	330	220	N	1111	0110	00
1179		721	N	1001	1110	01	01	1249		793	N	0110	0111	01	10	1319		425	N	0110	1111	01
1180		715	N	1001	0111	10	10	1250	313	594	N	0011	1111	00	01	1320		220	N	0110	1111	10
1181		721	N	0111	1001	10	10	1251		561	N	1111	0011	01	00	1321		425	N	1111	0110	00
1182	296	724	N	0110	1110	01	01	1252		594	N	1111	1100	10	00	1322	331	221	N	1111	1010	00
1183		732	N	1110	0110	01	01	1253		561	N	1100	1111	00	10	1323		421	N	1010	1111	01
1184		724	N	0111	0110	10	10	1254	314	592	N	0101	1111	00	01	1324		221	N	0101	1111	10
1185		732	N	0110	0111	10	10	1255		562	N	1111	0101	01	00	1325		421	N	1111	0101	00
1186	297	725	Y	1010	1110	01	01	1256		592	N	1111	1010	10	00	1326	332	223	N	1111	1100	00
1187		734	Y	1110	1010	01	01	1257		562	N	1010	1111	00	10	1327		420	N	1100	1111	01
1188		725	Y	0111	0101	10	10	1258	315	563	N	1001	1111	00	01	1328		223	N	0011	1111	10
1189		734	Y	0101	0111	10	10	1259		563	N	1111	1001	01	00	1329		420	N	1111	0011	00
1190	298	727	N	1100	1110	01	01	1260		563	N	1111	1001	10	00	1330	333	609	N	0111	1111	00

Ornt - Orientation Number

Cas - Case Number

Pce - Piece Number

N

Ornt	Cas	Pce	N	Bit-Codes	Ornt	Cas	Pce	N	Bit-Codes	Ornt	Cas	Pce	N	Bit-Codes
1401		423	N	0001 1001 10 11	1471		502	N	0010 1001 11 01	1541		531	N	1110 0000 10
1402	351	229	N	0011 0001 01 11	1472		290	N	0100 1001 11 10	1542	386	335	N	1011 0000 01
1403		521	N	0001 0011 11 01	1473		502	N	1001 0100 10 11	1543		335	N	0000 1011 11
1404		229	N	1000 1100 11 10	1474	369	293	Y	0110 0010 01 11	1544		335	N	0000 1101 11
1405		521	N	1100 1000 10 11	1475		505	Y	0010 0110 11 01	1545		335	N	1101 0000 10
1406	352	231	Y	0101 0001 01 11	1476		293	Y	0100 0110 11 10	1546	387	337	N	1101 0000 01
1407		519	Y	0001 0101 11 01	1477		505	Y	0110 0100 10 11	1547		526	N	0000 1101 11
1408		231	Y	1000 1010 11 10	1478	370	294	N	1010 0010 01 11	1548		337	N	0000 1011 11
1409		519	Y	1010 1000 10 11	1479		501	N	0010 1010 11 01	1549		526	N	1011 0000 10
1410	353	232	N	1001 0001 01 11	1480		294	N	0100 0101 11 10	1550	388	341	N	1110 0000 01
1411		515	N	0001 1001 11 01	1481		501	N	0101 0100 10 11	1551		525	N	0000 1110 11
1412		232	N	1000 1001 11 10	1482	371	296	N	1100 0010 01 11	1552		341	N	0000 0111 11
1413		515	N	1001 1000 10 11	1483		500	N	0010 1100 11 01	1553		525	N	0111 0000 10
1414	354	235	N	0110 0001 01 11	1484		296	N	0100 0011 11 10	1554	389	551	N	0001 0111 00
1415		518	N	0001 0110 11 01	1485		500	N	0011 0100 10 11	1555		640	N	0111 0001 11
1416		235	N	1000 0110 11 10	1486	372	305	N	0001 1100 01 11	1556		551	N	1110 1000 11

1417	518	N	0110	1000	10	11	1487	389	N	1100	0001	11	01	1557	640	N	1000	1110	00		
1418	355	236	N	1010	0001	01	11	1488	305	N	0011	1000	11	10	1558	390	555	N	0010	0111	00
1419	514	N	0001	1010	11	01	1489	389	N	1000	0011	10	11	1559	639	N	0111	0010	11		
1420	236	N	1000	0101	11	10	1490	373	309	N	0010	1100	01	11	1560	555	N	1110	0100	11	
1421	514	N	0101	1000	10	11	1491	388	N	1100	0010	11	01	1561	639	N	0100	1110	00		
1422	356	238	N	1100	0001	01	11	1492	309	N	0011	0100	11	10	1562	391	557	N	0100	0111	00
1423	513	N	0001	1100	11	01	1493	388	N	0100	0011	10	11	1563	637	N	0111	0100	11		
1424	238	N	1000	0011	11	10	1494	374	311	N	0100	1100	01	11	1564	557	N	1110	0010	11	
1425	513	N	0011	1000	10	11	1495	386	N	1100	0100	11	01	1565	637	N	0010	1110	00		
1426	357	255	N	0000	1110	01	11	1496	311	N	0011	0010	11	10	1566	392	558	N	1000	0111	00
1427	362	N	1110	0000	11	01	1497	386	N	0010	0011	10	11	1567	633	N	0111	1000	11		
1428	255	N	0111	0000	11	10	1498	375	312	N	1000	1100	01	11	1568	558	N	1110	0001	11	
1429	362	N	0000	0111	10	11	1499	382	N	1100	1000	11	01	1569	633	N	0001	1110	00		
1430	358	262	N	0001	0110	01	11	1500	312	N	0011	0001	11	10	1570	393	564	N	0001	1011	00
1431	471	N	0110	0001	11	01	1501	382	N	0001	0011	10	11	1571	596	N	1011	0001	11		
1432	262	N	0110	1000	11	10	1502	376	315	N	0101	0100	01	11	1572	564	N	1101	1000	11	
1433	471	N	1000	0110	10	11	1503	484	N	0100	0101	11	01	1573	596	N	1000	1101	00		
1434	359	266	N	0010	0110	01	11	1504	315	N	0010	1010	11	10	1574	394	568	N	0010	1011	00
1435	470	N	0110	0010	11	01	1505	484	N	1010	0010	10	11	1575	595	N	1011	0010	11		
1436	266	N	0110	0100	11	10	1506	377	317	N	0110	0100	01	11	1576	568	N	1101	0100	11	
1437	470	N	0100	0110	10	11	1507	483	N	0100	0110	11	01	1577	595	N	0100	1101	00		
1438	360	268	N	0100	0110	01	11	1508	317	N	0010	0110	11	10	1578	395	570	N	0100	1011	00
1439	468	N	0110	0100	11	01	1509	483	N	0110	0010	10	11	1579	593	N	1011	0100	11		
1440	268	N	0110	0010	11	10	1510	378	318	N	1100	0100	01	11	1580	570	N	1101	0010	11	
1441	468	N	0010	0110	10	11	1511	481	N	0100	1100	11	01	1581	593	N	0010	1101	00		
1442	361	269	N	1000	0110	01	11	1512	318	N	0010	0011	11	10	1582	396	571	N	1000	1011	00
1443	464	N	0110	1000	11	01	1513	481	N	0011	0010	10	11	1583	589	N	1011	1000	11		
1444	269	N	0110	0001	11	10	1514	379	322	N	0011	1000	01	11	1584	571	N	1101	0001	11	
1445	464	N	0001	0110	10	11	1515	442	N	1000	0011	11	01	1585	589	N	0001	1101	00		
1446	362	276	N	0001	1010	01	11	1516	322	N	0001	1100	11	10	1586	397	574	N	0011	0011	00
1447	416	N	1010	0001	11	01	1517	442	N	1100	0001	10	11	1587	671	N	0011	0011	11		
1448	276	N	0101	1000	11	10	1518	380	323	N	0101	1000	01	11	1588	574	N	1100	1100	11	
1449	416	N	1000	0101	10	11	1519	440	N	1000	0101	11	01	1589	671	N	1100	1100	00		
1450	363	280	N	0010	1010	01	11	1520	323	N	0001	1010	11	10	1590	398	575	N	0101	0011	00
1451	415	N	1010	0010	11	01	1521	440	N	1010	0001	10	11	1591	669	N	0011	0101	11		
1452	280	N	0101	0100	11	10	1522	381	324	N	1001	1000	01	11	1592	575	N	1100	1010	11	
1453	415	N	0100	0101	10	11	1523	436	N	1000	1001	11	01	1593	669	N	1010	1100	00		
1454	364	282	N	0100	1010	01	11	1524	324	N	0001	1001	11	10	1594	399	576	N	1001	0011	00
1455	413	N	1010	0100	11	01	1525	436	N	1001	0001	10	11	1595	576	N	0011	1001	11		
1456	282	N	0101	0010	11	10	1526	382	327	N	0110	1000	01	11	1596	576	N	1100	1001	11	
1457	413	N	0010	0101	10	11	1527	439	N	1000	0110	11	01	1597	576	N	1001	1100	00		
1458	365	283	N	1000	1010	01	11	1528	327	N	0001	0110	11	10	1598	400	579	N	0110	0011	00
1459	409	N	1010	1000	11	01	1529	439	N	0110	0001	10	11	1599	668	N	0011	0110	11		
1460	283	N	0101	0001	11	10	1530	383	328	N	1010	1000	01	11	1600	579	N	1100	0110	11	
1461	409	N	0001	0101	10	11	1531	435	N	1000	1010	11	01	1601	668	N	0110	1100	00		
1462	366	287	N	0011	0010	01	11	1532	328	N	0001	0101	11	10	1602	401	580	N	1010	0011	00
1463	508	N	0010	0011	11	01	1533	435	N	0101	0001	10	11	1603	665	N	0011	1010	11		
1464	287	N	0100	1100	11	10	1534	384	330	Y	1100	1000	01	11	1604	580	N	1100	0101	11	
1465	508	N	1100	0100	10	11	1535	434	Y	1000	1100	11	01	1605	665	N	0101	1100	00		
1466	367	289	N	0101	0010	01	11	1536	330	Y	0001	0011	11	10	1606	402	582	N	1100	0011	00
1467	506	N	0010	0101	11	01	1537	434	Y	0011	0001	10	11	1607	664	N	0011	1100	11		
1468	289	N	0100	1010	11	10	1538	385	334	N	0111	0000	01	11	1608	582	N	1100	0011	11	
1469	506	N	1010	0100	10	11	1539	531	N	0000	0111	11	01	1609	664	N	0011	1100	00		
1470	368	290	N	1001	0010	01	11	1540	334	N	0000	1110	11	10	1610	403	599	N	0101	0101	00

Ornt - Orientation Number

Cas - Case Number

Pce - Piece Number

N

Ornt	Cas	Pce	N	Bit-Codes				Ornt	Cas	Pce	N	Bit-Codes				Ornt	Cas	Pce	N	Bit-Codes			
----	----	----	----	-----	-----	-----	-----	----	----	----	----	-----	-----	-----	-----	----	----	----	----	-----	-----	-----	-----
1681		739	N	0010	0111	10	10	1751		828	N	0101	1110	01	00	1821		127	N	0000	0100	11	
1682	421	729	N	1000	1110	01	01	1752		772	N	1010	0111	10	00	1822	456	190	N	0000	0011	01	
1683		740	N	1110	1000	01	01	1753		828	N	0111	1010	00	10	1823		498	N	0011	0000	11	
1684		729	N	0111	0001	10	10	1754	439	773	N	1110	1001	00	01	1824		190	N	1100	0000	11	
1685		740	N	0001	0111	10	10	1755		823	N	1001	1110	01	00	1825		498	N	0000	1100	10	
1686	422	733	N	1100	0110	01	01	1756		773	N	1001	0111	10	00	1826	457	226	N	0000	1001	01	
1687		738	N	0110	1100	01	01	1757		823	N	0111	1001	00	10	1827		431	N	1001	0000	11	
1688		733	N	0110	0011	10	10	1758	440	218	N	1111	0001	00	01	1828		226	N	1001	0000	11	
1689		738	N	0011	0110	10	10	1759		430	N	0001	1111	01	00	1829		431	N	0000	1001	10	
1690	423	204	N	0000	1111	10	01	1760		218	N	1000	1111	10	00	1830	458	233	Y	0001	0001	01	
1691		376	N	1111	0000	01	10	1761		430	N	1111	1000	00	10	1831		523	Y	0001	0001	11	
1692		204	N	1111	0000	10	01	1762	441	776	N	0011	1110	00	01	1832		233	Y	1000	1000	11	
1693		376	N	0000	1111	01	10	1763		815	N	1110	0011	01	00	1833		523	Y	1000	1000	10	
1694	424	747	N	0001	0111	10	01	1764		776	N	0111	1100	10	00	1834	459	237	N	0010	0001	01	
1695		799	N	0111	0001	01	10	1765		815	N	1100	0111	00	10	1835		522	N	0001	0010	11	
1696		747	N	1110	1000	10	01	1766	442	778	N	0110	1110	00	01	1836		237	N	1000	0100	11	
1697		799	N	1000	1110	01	10	1767		814	N	1110	0110	01	00	1837		522	N	0100	1000	10	
1698	425	751	N	0010	0111	10	01	1768		778	N	0111	0110	10	00	1838	460	239	N	0100	0001	01	
1699		806	N	0111	0010	01	10	1769		814	N	0110	0111	00	10	1839		520	N	0001	0100	11	
1700		751	N	1110	0100	10	01	1770	443	779	N	1010	1110	00	01	1840		239	N	1000	0010	11	
1701		806	N	0100	1110	01	10	1771		812	N	1110	1010	01	00	1841		520	N	0010	1000	10	
1702	426	753	N	0100	0111	10	01	1772		779	N	0111	0101	10	00	1842	461	240	N	1000	0001	01	
1703		805	N	0111	0100	01	10	1773		812	N	0101	0111	00	10	1843		516	N	0001	1000	11	
1704		753	N	1110	0010	10	01	1774	444	781	N	1110	0110	00	01	1844		240	N	1000	0001	11	
1705		805	N	0010	1110	01	10	1775		827	N	0110	1110	01	00	1845		516	N	0001	1000	10	
1706	427	754	N	1000	0111	10	01	1776		781	N	0110	0111	10	00	1846	462	270	N	0000	0110	01	
1707		803	N	0111	1000	01	10	1777		827	N	0111	0110	00	10	1847		472	N	0110	0000	11	
1708		754	N	1110	0001	10	01	1778	445	782	N	1110	1010	00	01	1848		270	N	0110	0000	11	
1709		803	N	0001	1110	01	10	1779		822	N	1010	1110	01	00	1849		472	N	0000	0110	10	
1710	428	757	N	0110	0101	10	01	1780		782	N	0101	0111	10	00	1850	463	284	N	0000	1010	01	
1711		808	N	0101	0110	01	10	1781		822	N	0111	0101	00	10	1851		417	N	1010	0000	11	
1712		757	N	1010	0110	10	01	1782	446	222	N	1111	0010	00	01	1852		284	N	0101	0000	11	
1713		808	N	0110	1010	01	10	1783		429	N	0010	1111	01	00	1853		417	N	0000	0101	10	
1714	429	761	N	0010	1110	10	01	1784		222	N	0100	1111	10	00	1854	464	291	N	0001	0010	01	
1715		795	N	1110	0010	01	10	1785		429	N	1111	0100	00	10	1855		510	N	0010	0001	11	
1716		761	N	0111	0100	10	01	1786	447	784	N	0111	1100	00	01	1856		291	N	0100	1000	11	
1717		795	N	0100	0111	01	10	1787		820	N	1100	0111	01	00	1857		510	N	1000	0100	10	
1718	430	762	N	0011	0110	10	01	1788		784	N	0011	1110	10	00	1858	465	295	Y	0010	0010	01	
1719		797	N	0110	0011	01	10	1789		820	N	1110	0011	00	10	1859		509	Y	0010	0010	11	
1720		762	N	0110	1100	10	01	1790	448	785	Y	1110	1100	00	01	1860		295	Y	0100	0100	11	
1721		797	N	1100	0110	01	10	1791		819	Y	1100	1110	01	00	1861		509	Y	0100	0100	10	
1722	431	596	N	0001	1111	00	01	1792		785	Y	0011	0111	10	00	1862	466	297	N	0100	0010	01	
1723		564	N	1111	0001	01	00	1793		819	Y	0111	0011	00	10	1863		507	N	0010	0100	11	
1724		596	N	1111	1000	10	00	1794	449	224	N	1111	0100	00	01	1864		297	N	0100	0010	11	
1725		564	N	1000	1111	00	10	1795		427	N	0100	1111	01	00	1865		507	N	0010	0100	10	
1726	432	595	N	0010	1111	00	01	1796		224	N	0010	1111	10	00	1866	467	298	N	1000	0010	01	
1727		568	N	1111	0010	01	00	1797		427	N	1111	0010	00	10	1867		503	N	0010	1000	11	
1728		595	N	1111	0100	10	00	1798	450	225	N	1111	1000	00	01	1868		298	N	0100	0001	11	
1729		568	N	0100	1111	00	10	1799		423	N	1000	1111	01	00	1869		503	N	0001	0100	10	
1730	433	593	N	0100	1111	00	01	1800		225	N	0001	1111	10	00	1870	468	313	N	0000	1100	01	
1731		570	N	1111	0100	01	00	1801		423	N	1111	0001	00	10	1871		390	N	1100	0000	11	
1732		593	N	1111	0010	10	00	1802	451	613	N	0011	1111	00	00	1872		313	N	0011	0000	11	
1733		570	N	0010	1111	00	10	1803		605	N	1111	0011	00	00	1873		390	N	0000	0011	10	
1734	434	589	N	1000	1111	00	01	1804		613	N	1111	1100	00	00	1874	469	319	N	0100	0100	01	
1735		571	N	1111	1000	01	00	1805		605	N	1100	1111	00	00	1875		485	N	0100	0100	11	
1736		589	N	1111	0001	10	00	1806	452	611	N	0101	1111	00	00	1876		319	N	0010	0010	11	

1737		571	N	0001	1111	00	10	1807		606	N	1111	0101	00	00	1877		485	N	0010	0010	10
1738	435	767	N	1100	0111	00	01	1808		611	N	1111	1010	00	00	1878	470	325	N	0001	1000	01
1739		826	N	0111	1100	01	00	1809		606	N	1010	1111	00	00	1879		444	N	1000	0001	11
1740		767	N	1110	0011	10	00	1810	453	823	N	1101	0111	00	00	1880		325	N	0001	1000	11
1741		826	N	0011	1110	00	10	1811		773	N	0111	1101	00	00	1881		444	N	1000	0001	10
1742	436	769	N	1110	0011	00	01	1812		823	N	1110	1011	00	00	1882	471	329	N	0010	1000	01
1743		830	N	0011	1110	01	00	1813		773	N	1011	1110	00	00	1883		443	N	1000	0010	11
1744		769	N	1100	0111	10	00	1814	454	94	N	0000	0001	11	11	1884		329	N	0001	0100	11
1745		830	N	0111	1100	00	10	1815		129	N	0001	0000	11	11	1885		443	N	0100	0001	10
1746	437	771	N	0110	1101	00	01	1816		94	N	1000	0000	11	11	1886	472	331	N	0100	1000	01
1747		818	N	1101	0110	01	00	1817		129	N	0000	1000	11	11	1887		441	N	1000	0100	11
1748		771	N	1011	0110	10	00	1818	455	120	N	0000	0010	11	11	1888		331	N	0001	0010	11
1749		818	N	0110	1011	00	10	1819		127	N	0010	0000	11	11	1889		441	N	0010	0001	10
1750	438	772	N	1110	0101	00	01	1820		120	N	0100	0000	11	11	1890	473	332	Y	1000	1000	01

Ornt - Orientation Number

Cas - Case Number

Pce - Piece Number

N

Ornt	Cas	Pce	N	Bit-Codes	Ornt	Cas	Pce	N	Bit-Codes	Ornt	Cas	Pce	N	Bit-Codes
----	---	---	-	-----	----	---	---	-	-----	----	---	---	-	-----
1961		687	Y	1010 1000 00 11	2031		821	N	1100 0110 01 00	2101		688	N	0010 1000 00
1962	491	620	N	1001 0001 00 11	2032		786	N	0011 0110 10 00	2102	526	628	N	1000 0001 00
1963		620	N	0001 1001 11 00	2033		821	N	0110 0011 00 10	2103		684	N	0001 1000 11
1964		620	N	1000 1001 11 00	2034	509	787	N	1110 0100 00 01	2104		628	N	1000 0001 11
1965		620	N	1001 1000 00 11	2035		829	N	0100 1110 01 00	2105		684	N	0001 1000 00
1966	492	623	N	0110 0001 00 11	2036		787	N	0010 0111 10 00	2106	527	662	N	0010 0010 00
1967		686	N	0001 0110 11 00	2037		829	N	0111 0010 00 10	2107		680	N	0010 0010 11
1968		623	N	1000 0110 11 00	2038	510	788	Y	1110 1000 00 01	2108		662	N	0100 0100 11
1969		686	N	0110 1000 00 11	2039		824	Y	1000 1110 01 00	2109		680	N	0100 0100 00
1970	493	624	N	1010 0001 00 11	2040		788	Y	0001 0111 10 00	2110	528	694	N	0011 0000 00
1971		683	N	0001 1010 11 00	2041		824	Y	0111 0001 00 10	2111		702	N	0000 0011 11
1972		624	N	1000 0101 11 00	2042	511	226	N	1111 0000 00 01	2112		694	N	0000 1100 11
1973		683	N	0101 1000 00 11	2043		431	N	0000 1111 01 00	2113		702	N	1100 0000 00
1974	494	626	N	1100 0001 00 11	2044		226	N	0000 1111 10 00	2114	529	695	N	0101 0000 00
1975		682	N	0001 1100 11 00	2045		431	N	1111 0000 00 10	2115		700	N	0000 0101 11
1976		626	N	1000 0011 11 00	2046	512	615	N	0001 1111 00 00	2116		695	N	0000 1010 11
1977		682	N	0011 1000 00 11	2047		608	N	1111 0001 00 00	2117		700	N	1010 0000 00
1978	495	648	N	0010 0110 00 11	2048		615	N	1111 1000 00 00	2118	530	789	N	1110 0000 00
1979		650	N	0110 0010 11 00	2049		608	N	1000 1111 00 00	2119		833	N	0000 1110 01
1980		648	N	0110 0100 11 00	2050	513	614	N	0010 1111 00 00	2120		789	N	0000 0111 10
1981		650	N	0100 0110 00 11	2051		612	N	1111 0010 00 00	2121		833	N	0111 0000 00
1982	496	658	N	0011 0010 00 11	2052		614	N	1111 0100 00 00	2122	531	348	Y	0000 0000 01
1983		679	N	0010 0011 11 00	2053		612	N	0100 1111 00 00	2123		538	Y	0000 0000 11
1984		658	N	0100 1100 11 00	2054	514	835	N	1100 0111 00 00	2124		348	Y	0000 0000 11
1985		679	N	1100 0100 00 11	2055		837	N	0111 1100 00 00	2125		538	Y	0000 0000 10
1986	497	660	N	0110 0010 00 11	2056		835	N	1110 0011 00 00	2126	532	629	N	0000 0001 00
1987		678	N	0010 0110 11 00	2057		837	N	0011 1110 00 00	2127		692	N	0001 0000 11
1988		660	N	0100 0110 11 00	2058	515	241	N	0000 0001 01 11	2128		629	N	1000 0000 11
1989		678	N	0110 0100 00 11	2059		524	N	0001 0000 11 01	2129		692	N	0000 1000 00
1990	498	661	N	1010 0010 00 11	2060		241	N	1000 0000 11 10	2130	533	697	N	0001 0000 00
1991		676	N	0010 1010 11 00	2061		524	N	0000 1000 10 11	2131		704	N	0000 0001 11
1992		661	N	0100 0101 11 00	2062	516	299	N	0000 0010 01 11	2132		697	N	0000 1000 11
1993		676	N	0101 0100 00 11	2063		511	N	0010 0000 11 01	2133		704	N	1000 0000 00
1994	499	693	N	0111 0000 00 11	2064		299	N	0100 0000 11 10	2134	534	701	Y	0010 0000 00
1995		698	N	0000 0111 11 00	2065		511	N	0000 0100 10 11	2135		703	Y	0000 0010 11
1996		693	N	0000 1110 11 00	2066	517	333	N	0000 1000 01 11	2136		701	Y	0000 0100 11

1997	698	N	1110	0000	00	11	2067	445	N	1000	0000	11	01	2137	703	Y	0100	0000	00	
1998	500	529	N	1011	0000	00	11	2068	333	N	0001	0000	11	10	2138	6	N	1001	1111	11
1999	339	N	0000	1011	11	00	2069	445	N	0000	0001	10	11	2139	6	N	1111	1001	11	
2000	529	N	0000	1101	11	00	2070	518	340	N	0001	0000	01	11	2140	8	N	0110	1111	11
2001	339	N	1101	0000	00	11	2071	537	N	0000	0001	11	01	2141	8	N	1111	0110	11	
2002	501	730	N	0000	1110	01	01	2072	340	N	0000	1000	11	10	2142	11	Y	0111	0111	11
2003	741	N	1110	0000	01	01	2073	537	N	1000	0000	10	11	2143	11	Y	1110	1110	11	
2004	730	N	0111	0000	10	10	2074	519	344	N	0010	0000	01	11	2144	18	N	1110	0111	11
2005	741	N	0000	0111	10	10	2075	536	N	0000	0010	11	01	2145	95	N	0111	1110	11	
2006	502	755	N	0000	0111	10	01	2076	344	N	0000	0100	11	10	2146	27	Y	1011	1011	11
2007	807	N	0111	0000	01	10	2077	536	N	0100	0000	10	11	2147	27	Y	1101	1101	11	
2008	755	N	1110	0000	10	01	2078	520	346	Y	0100	0000	01	11	2148	29	N	1101	1011	11
2009	807	N	0000	1110	01	10	2079	534	Y	0000	0100	11	01	2149	54	N	1011	1101	11	
2010	503	764	N	0010	0110	10	01	2080	346	Y	0000	0010	11	10	2150	6	N	1111	1111	00
2011	810	N	0110	0010	01	10	2081	534	Y	0010	0000	10	11	2151	6	N	1111	1111	11	
2012	764	N	0110	0100	10	01	2082	521	347	N	1000	0000	01	11	2152	27	Y	1111	1111	01
2013	810	N	0100	0110	01	10	2083	530	N	0000	1000	11	01	2153	27	Y	1111	1111	10	
2014	504	597	N	0000	1111	00	01	2084	347	N	0000	0001	11	10	2154	29	N	1111	1111	10
2015	572	N	1111	0000	01	00	2085	530	N	0001	0000	10	11	2155	54	N	1111	1111	01	
2016	597	N	1111	0000	10	00	2086	522	585	N	0000	0011	00	11	2156	10	N	0000	1111	11
2017	572	N	0000	1111	00	10	2087	674	N	0011	0000	11	00	2157	10	N	1111	0000	11	
2018	505	774	N	1110	0001	00	01	2088	585	N	1100	0000	11	00	2158	42	Y	0011	0011	11
2019	832	N	0001	1110	01	00	2089	674	N	0000	1100	00	11	2159	42	Y	1100	1100	11	
2020	774	N	1000	0111	10	00	2090	523	621	Y	0001	0001	00	11	2160	49	N	1100	0011	11
2021	832	N	0111	1000	00	10	2091	691	Y	0001	0001	11	00	2161	121	N	0011	1100	11	
2022	506	780	N	0010	1110	00	01	2092	621	Y	1000	1000	11	00	2162	67	Y	0101	0101	11
2023	816	N	1110	0010	01	00	2093	691	Y	1000	1000	00	11	2163	67	Y	1010	1010	11	
2024	780	N	0111	0100	10	00	2094	524	625	N	0010	0001	00	11	2164	71	N	1010	0101	11
2025	816	N	0100	0111	00	10	2095	690	N	0001	0010	11	00	2165	111	N	0101	1010	11	
2026	507	783	N	1110	0010	00	01	2096	625	N	1000	0100	11	00	2166	81	N	0110	1001	11
2027	831	N	0010	1110	01	00	2097	690	N	0100	1000	00	11	2167	81	N	1001	0110	11	
2028	783	N	0100	0111	10	00	2098	525	627	N	0100	0001	00	11	2168	542	N	1001	1111	00
2029	831	N	0111	0100	00	10	2099	688	N	0001	0100	11	00	2169	542	N	1111	1001	11	
2030	508	786	N	0110	1100	00	01	2100	627	N	1000	0010	11	00	2170	544	N	0110	1111	00

Ornt - Orientation Number

Cas - Case Number

Pce - Piece Number

N

Table 4 - Level Counts by Notchable & Holes

General Counts by Level and Holes									
Hol	Total	No-Movement	Some-Move	Level-1	Level-2	Level-3	Level-4	Level-5	Level-6
0	25062952	24984175	0	78777	0	0	0	0	
1	227537087	225581024	542311	1157414	156773	99565	0	0	
2	967578280	942154647	13560442	7901814	2483531	1475339	1794	713	
3	2562966111	2386180862	116780502	33230312	17215383	9475851	62568	20355	
4	4745611122	4047634323	495052442	96536249	69868539	35575955	719287	218614	2
5	6534920944	4805533213	1243114783	205667818	186814842	88397683	4114280	1233041	24
6	6953240417	4064497939	2030443841	333271901	350609675	156030758	13979223	4225601	118
7	5864033782	2453453939	2263436781	420565667	480047264	205460148	31072526	9523548	361
8	3990281962	1047037847	1758945647	420108315	491697973	209183900	47702916	14703954	753
9	2218794579	310161491	953655015	335959652	382741078	167692648	51682120	15680534	1056
10	1017259780	62099509	353541828	216763276	228036538	105064661	39281739	11370898	958
11	386810776	8092264	85459236	113328678	103679045	49763760	20415790	5453018	541
12	122359090	645659	12325819	48053838	35447852	16984948	7005092	1687362	185
13	32194807	27833	906482	16463438	8894488	3983107	1540468	337145	37
14	7019238	464	25858	4515922	1593068	615707	218008	45276	4
15	1256334	0	193	975373	194984	60029	21147	4275	
16	181583	0	0	161879	14468	3529	1429	268	
17	20560	0	0	19910	485	100	56	9	
18	1730	0	0	1730	0	0	0	0	
19	96	0	0	96	0	0	0	0	
20	5	0	0	5	0	0	0	0	
Tot	35657131235	20378085189	9327791180	2254762064	2359495986	1049867688	217818443	64504611	4045

Notchable Counts by Level and Holes									
Hol	Total	No-Movement	Some-Move	Level-1	Level-2	Level-3	Level-4	Level-5	Level-6
0	588	407	0	181	0	0	0	0	
1	5626	4252	0	1370	4	0	0	0	
2	31964	23964	403	7338	248	8	2	1	
3	119012	83975	5599	26801	2431	156	40	10	
4	330559	205628	35651	76045	11469	1358	311	94	
5	711998	366422	131897	170338	34904	6474	1405	536	
6	1238596	486529	328741	315734	79598	21236	4706	1949	
7	1773537	484982	588243	488820	144001	50487	11832	4990	
8	2127755	363350	778375	643380	215707	93701	23759	9230	
9	2157545	203955	765735	722604	270462	141564	39724	12917	
10	1863092	85342	550632	697476	284335	175083	54885	14220	
11	1372038	26421	273780	578352	246577	172209	60476	12846	1
12	861106	6314	82576	411982	169798	129135	50785	9431	1
13	457442	1296	11218	250042	88412	70634	30160	5196	
14	203405	180	187	127775	33769	26797	12533	2014	
15	73992	0	0	53544	9262	6859	3762	547	
16	21339	0	0	17751	1608	1199	686	95	
17	4628	0	0	4328	135	100	56	9	
18	700	0	0	700	0	0	0	0	
19	64	0	0	64	0	0	0	0	
20	5	0	0	5	0	0	0	0	
Tot	13354991	2343017	3553037	4594630	1592720	897000	295122	74085	4

Table 5 - Level-Type Counts &amp; Examples

Level-Type	General-Count	Notch-Cnt	--Example Assembly (LL format)--	Example Description-
0 0 0 0	20,378,085,189	2,343,017	55551131143224221131143224226666	8-SYMMETRIES
0 0 0 1	9,327,791,180	3,553,037	35351110513344221110613344223636	First occurrence
1 1 1 1	2,254,762,064	4,594,630	5555515513324221116113644666464	Coffin's Burr #305
2 2 2 2	2,146,842,081	1,275,780	35351111143352226616443602226464	1-HOLE NOTCHABLE
2 0 0 0	187,208,203	242,032	5555511113004006616113344226464	Notchable; fewest holes
2 2 0 0	25,445,702	74,908	50501131042204226633042204226666	Notchable; fewest holes
3 3 3 3	823,314,689	515,610	35350130113244221131113244226464	Notchable; fewest holes
3 0 0 0	149,310,783	222,660	5555511113004226616113344006464	Notchable; fewest holes
2 3 3 3	55,542,472	59,128	05050130113244221131113244226464	Notchable; fewest holes
3 3 0 0	16,791,186	56,621	05051131042204226633042204226666	Notchable; fewest holes
2 2 3 3	3,026,411	29,204	55550130113044551100113024220606	Notchable; fewest holes
2 3 0 0	1,865,671	13,777	5555511113004000016113344226464	Notchable; fewest holes
2 2 3 0	14,862	0	55351130000354221111110324623636	First occurrence
3 3 3 0	1,614	0	50505133042300221131042604600606	First occurrence
4 4 4 4	99,318,351	111,851	35350110513254221111013364663636	Notchable; fewest holes
4 0 0 0	72,998,623	91,701	55551105513554221106613664226666	Notchable; fewest holes
3 4 4 4	26,380,651	40,725	50500130113244221131113244226464	Notchable; fewest holes
2 4 4 4	6,652,268	16,402	50500130113504001131113644226464	Notchable; fewest holes
4 4 0 0	5,858,634	3,066	54540115003524221111003664666666	Notchable; fewest holes
3 4 0 0	2,507,288	1,796	5555511113004220016113344006464	Notchable; fewest holes
2 4 0 0	1,551,174	2,189	05050130143024221101143324223636	Notchable; fewest holes
3 3 4 4	1,425,476	14,503	50500115013504221111013364003636	Notchable; fewest holes
2 2 4 4	582,279	8,520	5555530013044551130113044220606	Notchable; fewest holes
2 3 4 4	399,507	4,369	50500130043004221136643664006666	Notchable; fewest holes
3 3 4 0	81,576	0	35350011113354220630643064266666	First occurrence
2 4 4 0	23,359	0	55551100513504221110113224626666	First occurrence
4 4 4 0	17,364	0	54550011113354221003613364063636	First occurrence
2 2 3 4	8,945	0	35055113042500501113043300226060	First occurrence
2 3 4 0	6,703	0	05551101013004001101403004226466	First occurrence
3 4 4 0	5,407	0	54550011113354221003613364066666	First occurrence
2 2 4 0	789	0	05355105043000221131043000020606	First occurrence
3 3 3 4	49	0	50505133042300221131042600600606	First occurrence
5 0 0 0	26,632,759	22,226	55551135510554221136610664226666	Notchable; fewest holes
5 5 5 5	15,086,540	19,591	50500130113224221131113224223636	Notchable; fewest holes
4 5 5 5	9,041,227	6,205	55550110013554551116013624226464	Notchable; fewest holes
4 4 5 5	3,626,396	1,786	54540130143204221131143204226060	Notchable; fewest holes
3 5 5 5	2,645,817	8,189	50500130113044221131113044223636	Notchable; fewest holes
4 5 0 0	2,315,098	2,934	54540115003544221111003664226666	Notchable; fewest holes
2 5 5 5	1,944,047	4,910	05550100513554221101013664666666	Notchable; fewest holes
2 4 5 5	823,645	1,249	05050130143024221131143024223636	Notchable; fewest holes
3 5 0 0	635,101	1,292	50500115003544221111003664666666	Notchable; fewest holes
5 5 0 0	490,006	655	54540100143324221131143024220606	Notchable; fewest holes
3 4 5 5	319,204	474	50500130003544001133003344226666	Notchable; fewest holes
2 2 5 5	259,762	1,838	50500133043304221133043304006666	Notchable; fewest holes
3 3 5 5	248,050	1,809	50500100113044221130113044226666	Notchable; fewest holes
2 5 0 0	128,904	225	05050100043020221131443000666666	Notchable; fewest holes
2 4 4 5	109,099	0	55551100513504221110113224226666	First occurrence
4 4 4 5	85,311	0	35551100513504221110113224223666	NELSON 4-HOLE
2 3 5 5	51,417	702	05050110003204221110043204226666	Notchable; fewest holes
4 4 5 0	32,779	0	55550011113354220603643364266666	NELSON
3 3 4 5	6,879	0	35051100143020521130043200223606	First occurrence
3 4 4 5	6,341	0	55550011113354221603643304066666	First occurrence
4 5 5 0	3,516	0	54550011113524221003613364063636	First occurrence
3 4 5 0	3,338	0	50541101013554551116003064226066	First occurrence
3 5 5 0	2,718	0	35051101013004001101403004226466	First occurrence

5	5	5	0	2,265	0	35051103103554521103102224223666	First occurrence
2	3	4	5	1,467	0	55550000003004221100613604226666	First occurrence
2	2	4	5	919	0	50500133003004001130003304226666	First occurrence
2	5	5	0	713	0	05055135042502501133040000220606	First occurrence
3	3	5	0	457	0	54551131142222000630643062266666	MARINEAU'S 10/12
2	2	5	0	430	0	50500130003054251101003004226060	First occurrence
2	4	5	0	370	0	50500000013204221110043024226660	First occurrence
2	2	3	5	20	0	54505130400004221136100004006060	First occurrence
2	3	5	0	14	0	50500100003004221110403064266460	First occurrence
3	3	3	5	2	0	54550011143000006103143000223606	First occurrence
6	0	0	0	1,407,765	1,752	55550130042000551131442660226666	Notchable; fewest holes
6	6	6	6	929,995	539	54541105413520221106413620226464	Notchable; fewest holes
4	6	6	6	374,315	293	35351103510254221103610264223636	Notchable; fewest holes

Level-Type	General-Count	Notch-Cnt	--Example Assembly (LL format)--	Example Description-			
5	6	6	6	300,045	119	35350130143050221131143060663636	Notchable; fewest holes
2	6	6	6	229,701	375	05050100513324221101013324226464	Notchable; fewest holes
3	6	6	6	182,120	206	50500105013324221101013324226464	Notchable; fewest holes
4	6	0	0	124,432	670	35350103540254221103600264223636	Notchable; fewest holes
5	6	0	0	81,012	123	05050130540054001136640664226666	Notchable; fewest holes
2	2	6	6	76,257	126	50550115013004001116013644226464	Notchable; fewest holes
4	4	6	6	56,351	11	00005505013544551130113024226666	Notchable; fewest holes
3	6	0	0	49,470	117	50500100003024221131003664666666	Notchable; fewest holes
6	6	0	0	37,483	0	35050030043020021130143320220666	L44AA CASE
4	5	6	6	34,528	9	55500105513504221101013304006464	Notchable; fewest holes
5	5	6	6	30,186	0	05051135513544226030013644663636	First occurrence
2	6	0	0	27,795	267	05050100003024221101043664666666	Notchable; fewest holes
3	5	6	6	27,177	5	54540133140020221131140004206060	Notchable; fewest holes
2	5	6	6	25,967	1	55500130142000001131142004226060	Notchable; fewest holes
3	3	6	6	14,199	17	50500105003504221136603664006666	Notchable; fewest holes
2	4	6	6	11,300	4	05050100143000221131143060666606	Notchable; fewest holes
3	4	6	6	7,408	0	54551101013004501106613604226060	First occurrence
2	3	6	6	4,037	11	05050130103004001131100224226606	Notchable; fewest holes
5	5	5	6	3,386	0	35051103103554551103102224223666	First occurrence
4	5	5	6	1,947	0	05051110013024521133013204223636	First occurrence
2	5	5	6	1,699	0	35051110013024521130013204223636	First occurrence
3	5	5	6	1,108	0	54540533013004051130003304226464	First occurrence
2	2	5	6	902	0	05055105003004001116003064226666	First occurrence
2	4	4	6	780	0	35351101013004051116003064226066	First occurrence
4	6	6	0	509	0	55545111113340251100003240226664	First occurrence
4	4	4	6	488	0	35351101013004051116003064226466	First occurrence
5	5	6	0	463	0	35055111013044001116003064226066	First occurrence
4	4	5	6	459	0	35351101013044001116003064226066	First occurrence
4	5	6	0	393	0	04005115403504521116003204226664	First occurrence
3	4	6	0	382	0	04005115003504521116003244226664	First occurrence
2	4	5	6	346	0	05055100003004051116003064226666	First occurrence
4	4	6	0	291	0	55350011110324220613640364263636	First occurrence
3	5	6	0	183	0	50500500013204221110043024226660	First occurrence
3	4	5	6	116	0	54541110413024021100013204226060	First occurrence
3	3	4	6	60	0	50500135043504001131042222003666	First occurrence



2	3	5	6	49	0	50500000113004051100643604226666	First occurrence
3	3	5	6	37	0	50500100113004051100643604223666	First occurrence
3	3	6	0	36	0	55351130140350221100040300620636	First occurrence
5	6	6	0	36	0	50505100143024221100003064266460	First occurrence
2	6	6	0	10	0	50500111503054251110003004226060	First occurrence
2	4	6	0	8	0	00500500513054251100113324226060	First occurrence
2	3	6	0	4	0	35350011113044000100043064220606	First occurrence
2	3	4	6	1	0	50500130140054251130000004226060	First occurrence
7	7	7	7	208,430	107	54541135410520221136410620226464	Notchable; fewest holes
7	0	0	0	201,721	522	05050100013224221131013644666464	Notchable; fewest holes
5	7	7	7	94,299	0	35350011113244226603643364223636	NELSON
6	7	7	7	42,751	3	54540105103542001106103642226464	Notchable; fewest holes
4	7	7	7	36,501	1	50500130003524221131000004000666	Notchable; fewest holes
5	6	7	7	12,254	6	54540135140024221131140000200606	Notchable; fewest holes
4	7	0	0	11,912	20	54540133140224221131140000006060	Notchable; fewest holes
7	7	0	0	11,854	0	35050030043020051130143320220666	L44AA CASE
5	7	0	0	10,624	0	35550530013044551130613344220636	First occurrence
3	7	7	7	9,343	14	05050130443250221100043000006666	Notchable; fewest holes
2	7	0	0	7,598	0	05551101013004001101403044223666	First occurrence
3	7	0	0	6,510	8	05055533510044221130113044006606	Notchable; fewest holes
6	7	0	0	6,094	0	35350011113254220603643364203636	First occurrence
2	7	7	7	4,862	1	05050130003044001131000224226606	Notchable; fewest holes
5	5	7	7	4,794	0	35550011113544220603043224223636	First occurrence
6	6	7	7	4,042	0	04000530503054256111103004226060	First occurrence
3	5	7	7	3,061	1	50500130140000021131143200220666	Notchable; fewest holes
4	5	7	7	3,016	0	55550011113544220603043224223636	First occurrence
4	4	7	7	2,634	0	54500035400520221130410620226460	First occurrence
2	5	7	7	1,963	0	50501110013044221133013004066606	First occurrence
4	6	7	7	1,536	0	55550130510004501136110044226060	First occurrence
3	3	7	7	1,288	0	50501110013004221133013044006606	First occurrence
2	2	7	7	1,138	1	50500130003524221101003004006606	Notchable; fewest holes
3	6	7	7	1,017	1	50500100003504001131003224226606	Notchable; fewest holes
3	4	7	7	935	0	55351100410344001101100344226636	First occurrence

Level-Type	General-Count	Notch-Cnt	--Example Assembly (LL format)--	Example Description-			
2	3	7	7	480	0	50501110013004221133013004006606	First occurrence
2	4	7	7	463	0	05051130140002021133443200223606	First occurrence
2	6	7	7	287	0	05050130000004221131003644620606	First occurrence
4	4	5	7	263	0	35355135040004001131642222000606	First occurrence
4	5	7	0	238	0	05550030112004001130043004226060	First occurrence
5	7	7	0	182	0	35551101013004221101403004006466	First occurrence
4	6	7	0	122	0	35350011113354000110643004226666	First occurrence
4	7	7	0	112	0	35550103003004001110003004226466	First occurrence
3	5	5	7	78	0	50500100003024221131003204226606	First occurrence
5	6	7	0	75	0	04005115413504521106113204226464	First occurrence
3	5	7	0	72	0	35050103013004001106403004226466	First occurrence
4	5	5	7	72	0	55541130143040001133642222006664	First occurrence
3	4	5	7	64	0	35051103100544551103040004223666	First occurrence
5	5	7	0	54	0	05055105003004221131003004620606	First occurrence
3	5	6	7	26	0	54501100143204251100003024226460	First occurrence

4	4	7	0	22	0	35550103003004001101403004226466	First occurrence
4	4	6	7	22	0	00500530513354251130110024226060	First occurrence
3	3	4	7	22	0	55540101103340221130003340006664	First occurrence
2	5	5	7	21	0	50500110113004501100613604226664	First occurrence
2	3	4	7	8	0	05050130000004221131003604620606	First occurrence
3	4	6	7	8	0	35350011113044000100643004226660	First occurrence
2	2	5	7	6	0	50500110013004501100643604226664	First occurrence
5	5	6	7	5	0	50500110113304001100613604226664	First occurrence
3	4	7	0	3	0	35050103003004001101403004226466	First occurrence
4	6	6	7	2	0	00005105013504521106443304226660	First occurrence
2	5	6	7	2	0	55505130140004501131040600226060	First occurrence
2	3	5	7	1	0	50500100113004001100643604226664	First occurrence
4	5	6	7	1	0	05055130043054001131142222006606	First occurrence
6	8	8	8	12,995	0	55550130510004501631110024226060	First occurrence
8	0	0	0	11,562	17	05050100013244221131013204226660	Notchable; fewest holes
8	8	8	8	10,409	2	50500105143500201101143624226060	Notchable; fewest holes
2	8	8	8	3,601	0	54551101013204221100613264006606	First occurrence
5	8	8	8	3,209	3	35350130100054021131103264220606	Notchable; fewest holes
4	8	8	8	2,632	1	50500130003524221131000044000666	Notchable; fewest holes
3	8	0	0	2,199	2	05550000513004021106113604226060	Notchable; fewest holes
7	8	8	8	1,929	0	35350011113254226003413644603636	First occurrence
7	8	0	0	1,921	0	35350011113354220603643264203636	First occurrence
4	8	0	0	1,360	0	35350011113254220603643304266666	First occurrence
3	8	8	8	1,276	1	50500130003524221101003044006606	Notchable; fewest holes
6	8	0	0	1,248	3	05550110503004001111603264223636	Notchable; fewest holes
5	8	0	0	1,170	0	35355003442222551103442600223666	First occurrence
8	8	0	0	794	0	50500003103304501103103304226466	First occurrence
6	6	8	8	751	0	50501101143524521106143000226060	First occurrence
3	6	8	8	539	0	50501133140002021130643200220636	First occurrence
4	5	8	8	447	0	55351101510344051110000364226636	First occurrence
2	8	0	0	387	0	05050030140000221130140224226636	First occurrence
4	4	8	8	373	0	50545035102040001130103040226664	First occurrence
2	2	8	8	312	0	50550130443004001110443204226060	First occurrence
6	7	8	8	309	0	00005035113544521116143344226660	First occurrence
5	6	8	8	303	1	50500105143000201101143624226060	Notchable; fewest holes
5	5	8	8	302	0	50501130142222501130643300006636	First occurrence
3	3	8	8	120	0	00005135003504521131002004223666	First occurrence
7	7	8	8	93	0	50545105003040001113003342226664	First occurrence
5	7	8	8	87	0	50500110013304001106113604226464	First occurrence
3	5	8	8	72	2	05550110513004001116013604226060	Notchable; fewest holes
2	3	8	8	70	0	50550100513054001111013004226466	First occurrence
4	6	8	8	66	0	05051131103224521130100004223606	First occurrence
4	7	8	8	61	0	55540110503004221110603664006060	First occurrence
3	4	8	8	61	0	35555103410044221103400044003666	First occurrence
2	5	8	8	56	0	55500003113004001113143304220606	First occurrence
2	4	8	8	35	0	55500033113004001133043004220606	First occurrence
2	6	8	8	17	0	55500033113004001130643304220606	First occurrence
6	8	8	0	4	0	50505130140024221130000064266460	First occurrence
4	4	5	8	3	0	00005115443500521136413600226460	First occurrence
6	6	8	0	2	0	50505130140024221130000064266060	First occurrence
3	5	8	0	2	0	00045115013504521106443604226660	First occurrence
2	7	8	8	2	0	50500110003304001106103604226464	First occurrence
3	3	4	8	2	0	50500135043504001131142222006636	First occurrence

Level-Type	General-Count	Notch-Cnt	--Example Assembly (LL format)--	Example Description-
3 4 5 8	2	0	05050130543054001131142222006664	First occurrence
4 5 6 8	1	0	00005135140500521131043200223666	First occurrence
9 0 0 0	3,484	16	50500100013224221131013224226464	Notchable; fewest holes
5 9 9 9	603	0	00005115403544521116603344223636	First occurrence
7 9 0 0	496	0	35051133103554221130000604620606	First occurrence
4 9 9 9	380	0	55350000140344021100140344226636	First occurrence
9 9 9 9	309	0	35050013543554220011113224623636	First occurrence
7 9 9 9	211	0	35350011113244226603043644603636	First occurrence
8 9 9 9	161	0	55351100412344221101100304000636	First occurrence
5 9 0 0	158	0	05050130000504521131003664220606	First occurrence
2 9 0 0	152	0	05055130040052001131640020220606	First occurrence
8 8 9 9	126	0	00005035113524521111643044226606	First occurrence
5 5 9 9	105	0	00005005013504521110403044223666	First occurrence
6 9 9 9	88	0	04005005113554521111443264220606	First occurrence
3 9 0 0	79	0	50550000113024001100043324220606	First occurrence
6 7 9 9	68	0	04005035113554521116143304226060	First occurrence
4 9 0 0	65	0	50500100003524221131003004006466	First occurrence
4 6 9 9	64	0	05051131143200221133140002220606	First occurrence
4 8 9 9	61	0	00005015113524521100613044226606	First occurrence
4 4 9 9	58	0	55350000140302001100140304226636	First occurrence
6 6 9 9	36	0	50501131143200221133140002226060	First occurrence
3 9 9 9	35	0	35055113440222001113640004223606	First occurrence
6 9 0 0	21	0	35551100143004001100003264220606	First occurrence
5 7 9 0	12	0	35550103013004221106403004006466	First occurrence
7 8 9 9	6	0	00005015113524521130613044226606	First occurrence
4 5 9 9	3	0	05350000140302501100140304226636	First occurrence
5 5 9 0	3	0	35550103003004221101403004006466	First occurrence
5 7 9 9	3	0	55500130510004001133040604226060	First occurrence
7 7 9 9	3	0	54550100143004001110003264220606	First occurrence
9 9 0 0	2	0	50501100013524221131003004006466	First occurrence
4 6 10 10	145	1	05550110503004001116603664226666	L46AA Notchable
4 4 10 10	101	1	54540130140000201131140024226060	Notchable; fewest holes
10 0 0 0	57	0	35350030043044251130143344220666	HORDERN/PJM
5 9 10 10	34	0	55355131140304001130642222000636	First occurrence
4 10 0 0	10	0	00005105013544521131003204226466	First occurrence
5 10 0 0	10	0	05050100013254221101043004003666	First occurrence
10 10 10 10	6	0	05550033010024001131040024220606	First occurrence
4 5 10 10	5	0	55355131140304001130642222000606	First occurrence
4 10 10 10	2	0	50501135103244221100003224006060	First occurrence
4 9 10 10	1	0	55545133143040001136042222006060	First occurrence
7 10 0 0	1	0	05051100013254221101043004003666	First occurrence
6 10 10 10	1	0	50505133140002551131042000220606	First occurrence
12 0 0 0	1	0	35550030542024221131642000220606	LOVE'S DOZEN
Totals	35,657,131,235	13,354,991		

Table 6 - Symmetry Type Counts & Examples

Summary of Assemblies by Symmetry Type

	GENERAL			NOTCHABLE		
	Logical	Physical	Fully-Rotated	Logical	Physical	Fully-Rot
1	35657007380	71314014760	855768177120	13348427	26696854	320362248
2MA	22515	22515	270180	4492	4492	53904
2MB	74644	74644	895728	1405	1405	16860
2R	24797	49594	297564	404	808	4848
3R	1758	3516	14064	193	386	1544
4MA	40	40	240	35	35	210
4MB	44	44	264	16	16	96
4R	4	8	24	0	0	0
6MB	51	51	204	17	17	68
8MB	1	1	3	1	1	3
24MB	1	1	1	1	1	1
TOTALS	35657131235	71314165174	855769655392	13354991	26704015	320439782

Total Cube Configurations 18509302102818816

Examples of each Symmetry Type

1	35355035043002251130443060223636	0	7	2	5	0	0	0	Bill's Baffling Burr
2MA	54541135410520221136410620226464	0	4	1	7	7	7	7	Basis for souvenir puzzle of IPP14
2MB	35355515543322221111443662666464	0	0	0	1	1	1	1	Notchable
2R	55555515543552556111143222266666	0	0	0	1	1	1	1	Notchable, Type 1 Partial Solution
3R	05050000003004021100043004220666	0	17	3	2	2	5	5	Notchable Level-5
4MA	55555535543554551131143224226666	0	0	0	1	1	1	1	Notchable
4MB	55555535543224221131143664666666	0	0	0	1	1	1	1	Notchable
4R	54351135543554221136643664223664	0	0	0	0	0	0	0	One of only Four 4R Assemblies
6MB	35355510543322221111443602666464	0	2	0	1	1	1	1	Notchable
8MB	55551135543554221136643664226666	0	0	0	0	0	0	0	Only 8MB Assembly
24MB	55551130043004221130043004226666	0	8	0	0	0	0	0	Only 24MB Assembly

Table 7 - Uniqueness Check Results

Holes	---Notchable---			----- General -----								
	----Level-5----			----Level-8----			----Level-9----			--Level-10---		
	Count	Uni	Pct	Count	Uni	Pct	Count	Uni	Pct	Cnt	Uni	Pct
0	0			0			0			0		
1	0			0			0			0		
2	1	0	0.0%	0			0			0		
3	10	4	40.0%	0			0			0		
4	94	11	11.7%	15	13	86.7%	0			0		
5	536	21	3.9%	1031	828	80.3%	23	21	91.3%	0		
6	1949	40	2.1%	3730	2128	57.1%	277	136	49.1%	0		
7	4990	31	0.6%	6754	1681	24.9%	924	154	16.7%	13	8	61.5%
8	9230	22	0.2%	10353	485	4.7%	1526	32	2.1%	36	10	27.8%
9	12917	10	0.1%	14415	95	0.7%	1714	11	0.6%	58	0	0.0%
10	14220	0	0.0%	14264	21	0.1%	1397	1	0.1%	96	0	0.0%
11	12846	0	0.0%	7816	3	0.0%	723	0	0.0%	110	0	0.0%
12	9431	0	0.0%	2121	0	0.0%	192	0	0.0%	51	0	0.0%
13	5196	0	0.0%	268	0	0.0%	16	0	0.0%	8	0	0.0%
14	2014	0	0.0%	16	0	0.0%	0			1	0	0.0%
15	547	0	0.0%	1	0	0.0%	0			0		
16	95	0	0.0%	0			0			0		
17	9	0	0.0%	0			0			0		
18	0			0			0			0		
19	0			0			0			0		
20	0			0			0			0		
Total	74085	139	0.2%	60784	5254	8.6%	6792	355	5.2%	373	18	4.8%

Notchable: no unique solutions over level-5  
no statistics below level-5  
General: no unique solutions over level-10  
no statistics below level-8

Table 8 - Apart-Type Summary

LL Format of Rotated Assembly (for standardized apart-code)	Cnt	Uni	PM	L	H	Lvs	LTyp	Asm	Sol	St	Move1	Move2	Move3	Ap Move
-----														
Level-10 Apart Types														
-----														
55541133040300220033440060200606	4	0	10	C	12	A-1	AAAA	672	541	28	112	* 1F6	* 2F4	* 314
05051131540002220030040204226636	4	0	10	8	11	A-2	7A00	270	141	25	112	* 211	* 1F5	* 214
54551133140350020030040300226666	5	0	10	6	10	A-1	A000	388	202	21	112	* 211	* 3145	114
05351130042044000030442062223606	1	0	13	C	11	A-1	6AAA	138	130	14	112	* 211	* 315	* 2F23
35051103540204200113440222003606	1	0	10	6	10	A-1	A000	89	50	34	112	313	111	* 1F23
35051103540204206113440222003606	1	0	10	6	9	A-1	A000	30	11	18	112	313	1F23	* 3F6
54551135403020221036402000066466	6	0	11	8	9	A-3	4A00	13	4	19	114	314	1F1	3E6
54500030403350251131402002226466	1	0	13	C	9	A-1	45AA	40	22	37	1146	325	1E2	* 2F35
54500030402350251131403300226466	4	0	12	C	9	A-1	45AA	38	11	45	1146	325	1E2	# 2F35
54500530403350251131402022226466	11	9	14	8	7	A-1	5A00	2	1	22	1146	325	1F2	2F35
54500530402350551131403302226466	35	9	12	C	7	A-1	59AA	7	1	27	1146	325	1F2	2F35
50541110003224221100143204226060	36	0	15	C	9	A-1	46AA	20	9	23	116	21246	121	2F24
50541110003224221100143204006060	3	0	13	C	11	A-1	46AA	52	35	30	116	21246	121	2F24
54541100003024221100143224226060	68	0	16	C	9	A-1	44AA	112	77	35	116	21246	121	# 2F24
50541110003224221100143224226060	139	0	16	C	8	A-1	46AA	10	4	19	116	21246	121	# 2F24
54551135143202220036040002226060	1	0	10	6	9	A-1	A000	46	26	16	116	2F3	1E2	213
54551131143202221136040002226060	49	0	10	6	7	A-1	A000	40	13	18	116	2F3	# 1E2	213
50501131443520220031140002226060	4	0	13	C	10	A-1	AAAA	176	123	20	116	2F35	1E2	215
-----														
Level-9 Apart Types														
-----														
35551103512054226003040064023666	4	4	10	6	8	9-2	9000	4	1	15	112	* 1F3	* 326	1F2
35351103510554220003042064023666	10	1	9	6	8	9-2	9000	18	1	24	112	* 1F3	* 326	1F2
35351133140204220030440002220606	8	0	13	8	10	9-1	2900	172	151	18	112	* 1F6	* 2F145	122
55351131140204220031040002220606	29	0	9	8	10	9-2	4900	204	65	22	112	* 1F6	* 2F4	122
54501131440204220633440002220606	8	0	11	8	9	9-1	2900	59	44	19	112	* 1F6	* 2F4	122
35350033040204221131440002220606	33	0	10	8	10	9-1	3900	172	151	20	112	* 1F6	* 2F4	# 122
35351133140204220031140002220606	80	0	9	8	9	9-2	5900	84	42	18	112	* 1F6	* 2F4	# 122
54505133140204221133140002220606	44	0	11	8	8	9-1	2900	33	12	15	112	* 1F6	* 2F4	122
35350033440204221131440002220606	23	0	12	8	9	9-1	3900	91	77	16	112	* 1F6	* 2F45	122
35351131440204220031140002220606	8	0	11	8	9	9-2	5900	116	70	17	112	* 1F6	* 2F45	# 122
35351530440342221130442202200606	126	0	10	6	7	9-1	9000	50	23	21	112	* 1F6	* 2F45	314
35551113440042220003440220223606	65	0	12	C	8	9-1	9999	24	8	18	112	* 211	* 3135	1F23
35551113140222220003040064203606	7	0	10	6	9	9-1	9000	20	11	20	112	* 211	* 3135	1F23
54501130140002220033040204226460	2	0	11	8	11	9-1	5900	57	34	16	112	2114	122	2F4
50540530540000051136142200226464	6	0	12	8	10	9-1	3900	127	105	18	112	* 214	* 3145	1124
50500031142200051136140060226466	8	0	12	C	10	9-2	3999	88	68	20	112	* 214	* 3145	1124
54501133442204221633640362060404	8	2	10	C	6	9-1	9999	7	1	15	112	2146	1F6	2E4
54501133042202221633640364060404	4	0	10	C	7	9-1	9999	26	4	17	112	2146	1F6	2F4
55541133042202221633640362060000	32	0	8	C	8	9-1	5999	27	5	26	112	* 216	* 1F6	* 2F4
55541133542202221633640362060000	40	0	8	C	7	9-1	5999	30	2	22	112	* 216	* 1F6	* 2F4
55541133542052221633640362060000	127	10	9	C	7	9-1	5999	17	1	17	112	* 216	* 1F6	* 2F4
35051113540044220113440222003606	8	0	9	C	8	9-1	9999	54	18	18	112	313	111	* 1F23
35051113540044226113440222003606	8	0	9	C	7	9-1	9999	20	5	13	112	313	1F23	* 3F6
05351135540352226130640062200606	72	0	11	6	8	9-1	9000	102	49	16	112	314	1F16	2F14
50551031110054020630100624226064	1	0	12	6	10	9-1	9000	53	24	21	1124	2114	335	2F14
55541131102042220033100342026664	6	0	10	C	7	9-1	9999	72	12	20	1124	# 316	* 3F4	* 1F2
54551135403500221036402000066466	17	2	9	8	9	9-2	4900	15	1	17	114	314	1F1	3E6
54551133403220226013403260066466	342	14	9	C	6	9-1	9999	8	1	15	114	314	* 1F1	* 3F6
54551133403220226010403260066466	100	0	8	C	7	9-1	9999	18	6	21	114	314	* 1F1	* 3F6
54551133403220226613403260066464	489	89	9	C	5	9-1	9999	3	1	13	114	314	* 3F6	* 1F1
54551133403220226610403620606466	144	12	8	C	6	9-1	5999	17	1	19	114	314	* 3F6	* 1F1
54551111403000220631403302266460	6	4	8	6	8	9-1	9000	3	1	22	114	* 316	1F2	* 212

54505533402252551136400602226466	19	19	12	C	5	9-1	7999	2	1	19	1146	2F35	115	213
54501533400552551131400240226466	238	39	10	C	6	9-1	9999	5	1	16	1146	2F35	115	213
54505535403350551101403220226466	249	33	11	C	6	9-1	8899	5	1	14	1146	2F35	115	213
54505513403350551106403260226466	150	24	11	C	6	9-1	8999	15	1	13	1146	2F35	115	213
54555033402520021133400002226466	1	0	13	C	8	9-1	4599	23	6	29	1146	2F35	1E2	2135
34555035403520221131400002226466	6	0	12	C	7	9-3	9999	8	2	14	1146	2F35	1E2	215
55541100013340551101403340226664	19	0	12	6	7	9-1	9000	16	6	21	1146	2F35	325	2135
54551500403340521101103340226664	1	1	13	6	7	9-1	9000	22	1	14	1146	2F35	325	2135
55541500013340251101013340226664	34	4	12	6	7	9-1	9000	7	1	15	1146	2F35	325	2135
54551130403300551131403320226466	28	3	12	6	6	9-1	9000	11	1	21	1146	2F35	325	2135
54550530403350521131403360226466	28	4	14	C	6	9-1	9999	2	1	15	1146	2F35	325	2135
54541530403350551131403360226466	188	54	13	6	5	9-1	9000	2	1	15	1146	2F35	325	2135
55541530003340551131103340226664	36	2	12	6	6	9-1	9000	4	1	19	1146	2F35	325	2135
50541531510240221133400640226664	86	0	11	C	6	9-1	6999	10	3	18	1146	313	1115	2F5

LL Format of Rotated Assembly  
(for standardized apart-code)

	Cnt	Uni	PM	L	H	Lvs	LTyp	Asm	Sol	St	Move1	Move2	Move3	Ap Move
54500530403350551131402022226466	13	5	10	C	7	9-1	5999	7	1	22	1146	325	1F2	2F35
50501110003244221100143224226060	64	0	15	C	9	9-1	4699	72	53	25	116	21246	121	2F24
50501131143200221133140002226060	36	0	15	C	9	9-1	6699	72	53	25	116	21246	1E2	2F24
50541131143202221133140002226060	117	0	13	6	7	9-2	9000	52	33	10	116	21246	1E2	2F24
54551131143200226036040602603000	3	0	9	6	10	9-1	9000	15	12	16	116	216	* 2F3	* 1E2
54555031143000001131042222606060	1	0	10	C	10	9-1	7999	16	5	21	116	2F23	312	213
54555031143000001131142222606060	3	0	12	C	9	9-1	9999	16	5	14	116	2F23	312	213
55351135143300000130442222606060	4	0	9	C	9	9-1	5999	51	23	13	116	2F23	312	213
55541131543000000130442222606060	1	0	10	C	10	9-1	5999	46	15	15	116	2F23	312	213
55550031142504001131043604226060	49	0	10	6	9	9-1	9000	276	96	18	116	2F23	3125	213
55055035112244001131143004226060	370	0	10	8	8	9-1	7900	73	20	29	116	2F23	3125	213
55050031442244001131443304226060	446	0	10	6	8	9-2	9000	204	63	28	116	2F23	3125	213
55055035112254001130043004226060	15	0	10	A	10	9-1	5790	38	17	29	116	2F23	3125	213
55055035112254001131143004226060	311	0	10	8	8	9-1	7900	48	14	26	116	2F23	3125	213
55050531542250001131443002226060	21	0	10	8	9	9-1	7900	100	57	26	116	2F23	3125	213
55050531512254001131413344226060	1532	0	10	6	6	9-1	9000	15	4	21	116	2F23	3125	213
55050531542250001131443342226060	72	0	10	6	7	9-1	9000	10	5	20	116	2F23	3125	213
54551131143202226031140002226060	470	4	9	6	7	9-3	9000	10	1	11	116	2F3	# 1E2	213
54541130143200221131140002226060	38	0	8	6	8	9-1	9000	52	34	25	116	2F3	# 1E2	213
54551131143202226036040002226060	8	0	10	6	8	9-1	9000	10	7	14	116	2F3	1E2	213
30305535442522521133140604226060	63	15	11	6	6	9-1	9000	1	1	12	116	2F35	115	213
30305535142522521133140604226060	141	10	10	6	6	9-1	9000	2	1	16	116	2F35	115	213
50505033442520221131140002026060	3	0	12	C	10	9-1	4999	58	37	20	116	2F35	1E2	2135
50501133442520021131140002226060	21	0	13	C	9	9-1	4999	58	15	18	116	2F35	1E2	2135
54541133143202221131040002226060	9	0	12	6	7	9-1	9000	26	15	10	116	2F35	1E2	2135
50505031443520021131140002226060	4	0	11	C	10	9-1	9999	128	92	19	116	2F35	1E2	215
55550130540052001133040604226060	9	0	9	8	11	9-2	6900	464	287	22	116	313	111	3D5
55550130540002551133040604226060	2	0	9	6	10	9-2	9000	166	108	15	116	313	111	3E5
55500130510004551133040604226060	12	0	9	C	11	9-1	7999	304	152	12	116	313	111	3E5
55550130540002501133440604226060	2	0	9	6	10	9-3	9000	239	137	21	116	313	111	3E5
55550130540002501133040604226060	4	0	10	8	11	9-2	9900	166	107	18	116	313	111	3E5
-----														
Level-8 Apart Types														
-----														
35551103440004226003112044063606	6	4	7	6	9	8-1	8000	4	1	23	112	* 1F3	* 316	* 212

35551103440004226003112044023606	3	2	7	6	9	8-1	8000	6	1	23	112	* 1F3	* 316	* 212
35551103512204226003040064023666	11	6	8	6	8	8-1	8000	2	1	17	112	* 1F3	* 326	1F2
35551103140522220003042062023666	19	0	7	6	8	8-1	8000	14	9	22	112	* 1F3	* 326	1F2
35055503440554221103142002223666	28	4	10	8	6	8-1	4800	7	1	19	112	* 1F36	* 2F45	112
35055503440552221103142004023666	24	3	9	C	7	8-1	4888	7	1	19	112	* 1F36	* 2F45	112
34055503540552021103142004223666	6	0	9	C	7	8-1	4888	2	2	28	112	* 1F36	* 2F45	112
35055503440554221103142202223666	20	15	10	8	5	8-1	4800	4	1	17	112	* 1F36	* 2F45	1F5
35055103440552221103140064023666	8	2	10	C	7	8-1	4888	17	1	17	112	* 1F36	* 2F45	1F5
35055503440552221103642204223666	377	231	10	C	5	8-1	4888	1	1	19	112	* 1F36	* 2F45	1F5
35550003040544221103442202223666	18	0	12	8	7	8-1	4800	66	28	23	112	* 1F36	* 2F45	325
35055130140204221131440002220606	4	0	11	8	9	8-2	5800	56	33	19	112	* 1F6	* 2F145	122
35051131540204221131140002220606	248	0	7	8	8	8-2	5800	96	48	18	112	* 1F6	* 2F4	# 122
55355030140204221131140002220606	178	0	8	8	9	8-2	6800	93	40	14	112	* 1F6	* 2F4	# 122
55541130042004220033440302200606	6	0	7	6	11	8-2	8000	72	34	17	112	* 1F6	* 2F4	# 314
54555030040054021133142204220606	51	0	7	6	9	8-1	8000	52	27	14	112	* 1F6	* 2F4	* 325
35051131440204221131140002220606	57	0	9	8	8	8-1	5800	48	22	16	112	* 1F6	* 2F45	122
35350031440204221131140002220606	3	0	10	8	9	8-2	5800	100	71	15	112	* 1F6	* 2F45	122
04045533542054051131442202220606	456	0	9	C	7	8-1	8888	36	15	15	112	* 1F6	* 2F45	1F5
35351530440342221130442200200606	134	0	8	6	8	8-1	8000	24	12	24	112	* 1F6	* 2F45	* 314
35351530440302221130442202200606	12	0	9	6	8	8-1	8000	60	34	19	112	* 1F6	* 2F45	314
35351513440342221133042200200606	335	6	8	6	7	8-1	8000	4	1	19	112	* 1F6	* 2F45	* 314
35351530440302221130042200200606	6	0	8	8	10	8-1	8800	34	22	31	112	* 1F6	* 314	* 2F45
35351530440302221130042202200606	6	0	9	6	9	8-1	8000	64	40	24	112	* 1F6	* 314	* 2F45
35351533440302221133042200200606	51	0	8	6	8	8-1	8000	28	9	29	112	* 1F6	* 314	* 2F45
50550031142044221131042002220606	30	0	9	C	9	8-1	5888	262	32	14	112	* 1F6	* 315	* 2E4
50550533042044221130642002220606	136	0	7	6	9	8-1	8000	29	10	16	112	* 1F6	* 315	* 2E4
05051131540002220031640204220666	37	0	7	8	10	8-1	6800	488	199	24	112	* 211	* 1F5	* 214
54551130440354020033040304226060	11	0	9	C	10	8-1	2888	456	184	22	112	* 211	* 2E4	* 325
35551113440004000003440222223606	4	0	10	C	10	8-1	4888	57	41	39	112	* 211	* 3135	1F23
35551113440044000003440222223606	22	0	10	C	9	8-1	8888	49	30	26	112	* 211	* 3135	1F23
35551113440222000003640062223606	2	0	9	C	9	8-1	8888	32	25	28	112	* 211	* 3135	1F23
35551113440204050003440222223606	95	0	10	C	8	8-1	8888	11	4	22	112	* 211	* 3135	1F23
35551113440222220003640062223606	54	0	10	C	7	8-1	8888	4	4	18	112	* 211	* 3135	1F23
35551113440044050003440222223606	26	0	10	C	8	8-1	8888	10	4	15	112	* 211	* 3135	1F23

LL Format of Rotated Assembly  
(for standardized apart-code)

	Cnt	Uni	PM	L	H	Lvs	LTyp	Asm	Sol	St	Move1	Move2	Move3	Ap Move
35551113440204220003040222063606	105	2	9	6	9	8-1	8000	3	1	14	112	* 211	* 3135	1F23
35551113440222220003640064203606	51	1	9	8	8	8-1	8800	14	1	17	112	* 211	* 3135	1F23
55551131042050020030640360226636	44	0	8	8	9	8-1	7800	60	36	32	112	* 211	* 314	* 325
55541133142202220036040062226636	2544	70	10	C	6	8-1	6888	22	1	16	112	* 211	* 3145	1124
55541131042202220030640062226636	12370	31	10	C	7	8-1	6888	20	1	15	112	* 211	* 3145	1124
54541135140200220036042060226636	216	0	10	C	8	8-1	8888	17	11	15	112	* 211	* 3145	114
55551130442050020030040360226636	42	0	8	8	10	8-2	5800	210	114	19	112	* 211	* 3145	114
55551133440350020033040360226636	2335	0	8	6	8	8-2	8000	224	79	14	112	* 211	* 3145	114
54551133142050020036040660226666	1018	0	9	C	8	8-1	4888	112	50	16	112	* 211	* 3145	114
55541133540350020036642060226666	1497	0	8	6	7	8-2	8000	42	16	12	112	* 211	* 3145	114
54551133442050020036642060226666	5152	0	9	C	7	8-1	5888	130	54	17	112	* 211	* 3145	114
54551133410352020030402002226460	34	0	8	6	9	8-1	8000	72	46	13	112	* 211	* 3145	114
50551135040044220033040602226460	12	0	7	6	10	8-1	8000	224	139	19	112	* 211	* 315	* 2E4
55551131040052020031640600220666	4	0	7	C	10	8-1	3888	96	46	38	112	* 211	* 325	1D2
55551130042052020036640600226064	8	0	7	C	10	8-1	4688	60	45	29	112	* 211	* 325	1D2



55551130140050020036040640226664	20	0	9	8	10	8-1	5800	688	361	33	112	*	211	*	325	*	1E2
55551130140052020036040640226664	25	0	10	8	9	8-1	5800	176	90	23	112	*	211	*	325	*	1F2
55551131042050020030640320226636	8	0	10	8	9	8-1	7800	60	32	24	112	*	211	*	325	*	1F2
55551131042054020030642222003636	80	17	8	8	8	8-1	7800	8	1	21	112	*	211	*	325		1F2
50501133440002220036410204226460	12	0	12	8	10	8-1	3800	150	87	19	112		2114		122		2F14
50501130440002220033410204226464	8	0	10	8	10	8-1	3800	119	80	14	112		2114		122		2F14
50500033042002021136040622226464	22	0	11	C	10	8-1	5788	153	96	18	112	#	214	#	1126	#	3145
54501131040002221133440204226460	219	0	8	8	8	8-1	3800	27	8	18	112		214		122		2E4
50501131140002221633640204226060	20	0	8	8	9	8-1	5800	296	79	25	112		214		122		2E4
50501133040002221131440204226460	48	0	9	8	9	8-1	3800	96	53	24	112		214		122		2E4
50501131140002221133140204223636	642	0	7	8	7	8-1	4800	44	15	15	112		214	#	122		2F4
50501131140002226033140204223666	180	0	8	8	8	8-2	5800	47	19	12	112		214	#	122		2F4
50501133140002221136440204226460	363	0	10	8	8	8-1	3800	143	54	17	112		214	#	122		2F4
50501131140002226133140204226464	693	4	8	8	7	8-1	5800	40	1	13	112		214	#	122		2F4
50501133440002221131440204226460	77	0	10	8	8	8-1	3800	68	33	20	112		214		122		2F4
50505030142200201136140060226466	6	0	10	C	10	8-1	2888	52	41	25	112	*	214	*	3145		1124
50540533540002001136440664226464	56	0	13	8	8	8-1	6800	25	11	14	112	#	214	#	3145		1124
50541133140304220630040364026466	24	1	10	8	8	8-1	7800	74	1	11	112	*	214	*	326		1F2
50501131440002221133440204223636	380	0	9	8	7	8-1	3800	41	13	13	112		2146		122		2F46
54501135442204221633640362060404	28	3	8	C	6	8-1	8888	4	1	12	112	#	2146	#	1F6	#	2E4
50501135542202221633640364060404	16	2	8	C	7	8-1	8888	9	1	12	112	#	2146	#	1F6	#	2F4
54541135040522221633642062060000	18	0	9	C	8	8-1	7888	35	25	19	112	*	216	*	1F6	*	2F4
55541135542052221633640362060000	268	22	7	C	7	8-1	5888	18	1	15	112	*	216	*	1F6	*	2F4
54501133540552221633640364060000	3	0	8	C	8	8-1	5888	12	5	18	112	*	216	*	1F6	*	314
50540533040342021131040344226664	36	0	10	6	7	8-1	8000	26	10	14	112		234		1F2	*	315
35051113440222220113440204063606	172	2	9	C	7	8-1	8888	4	1	21	112		313	#	111	*	1114
35051113440222226113440204063606	175	11	9	C	6	8-1	8888	4	1	14	112		313	#	11146		3F6
35051113040222206113640200063606	4	1	10	6	9	8-1	8000	4	1	21	112		313		1F23		2123
35051113410044226013440222003636	8	1	10	C	7	8-1	8888	20	1	16	112		3136		11146		3E6
35051113140054200013040222223636	18	0	9	6	8	8-1	8000	23	15	19	112		3136		1F23		3F6
55351135140052200630040002226460	3	0	8	6	10	8-1	8000	34	30	19	112	*	314	*	1124	*	214
05355011540352221111640344000636	149	3	8	6	7	8-3	8000	3	1	12	112		314		1F1		3F3
05351135540352226130642002200606	337	0	10	6	8	8-1	8000	72	35	12	112		314		1F16		2F14
05351135542202226133040302200606	72	0	10	6	8	8-1	8000	67	12	11	112		314		1F16		2F14
35351133542202226133040302200606	399	0	11	C	7	8-1	8888	43	5	14	112		314		1F16		2F14
55551131140350020030440300226636	4	0	8	6	9	8-1	8000	164	64	22	112	*	314	*	211	*	325
55551131142050020030440300226636	4	0	7	6	9	8-1	8000	52	37	25	112	*	314	*	211	*	325
55351135140052200630040002226664	9	0	9	6	9	8-1	8000	14	8	15	112	*	3146		1124	*	214
55351135140052200031142202226664	171	43	9	6	6	8-1	8000	19	1	16	112	#	3146		1124	#	214
55351135140052200033142202226664	51	8	10	6	6	8-1	8000	34	1	14	112	#	3146		1124	#	214
54501135142000220033440360026666	24	0	8	C	9	8-1	8888	73	58	10	112		3146		114		3F6
50501135542000220033440360026666	16	0	10	C	10	8-1	8888	256	197	20	112		3146		1145		3F6
55351131440300220030402062026466	15	0	9	6	9	8-1	8000	44	6	17	112		3146		1145		3F6
55351133440300220033410362026466	112	12	9	6	7	8-2	8000	8	1	14	112		3146		1145		3F6
55351131140300220030442060026666	45	0	9	6	9	8-1	8000	135	75	22	112		3146		1145		3F6
50501133140322220030040362026066	18	0	10	C	10	8-1	6788	184	133	20	112	*	326		1F2	*	2124
55551131010554226630040064026666	170	0	8	6	7	8-1	8000	68	18	12	112	#	326		1F2	#	313
55541133100342226036100042206464	4	1	8	C	7	8-1	8888	6	1	15	1124		316	*	3F4	*	1E2
55541133102042220033100342026664	17	0	8	C	7	8-1	8888	72	12	18	1124		316	*	3F4	*	1F2
55541133100340200036100342226464	2	0	10	C	8	8-1	8888	20	6	18	1124		3F4	*	1E2	*	2114
55541130100542200033000342226664	3	0	9	6	9	8-1	8000	51	15	31	1124		3F4		1E2	*	2114
55541133100342226036102042206464	8	1	8	C	6	8-1	8888	5	1	12	1124		3F4		1E2		316
55541133500342020033602042226664	5	0	10	C	7	8-3	8888	70	11	28	1124		3F4		1F2	*	2114
55541133500342020036600342226464	31	0	10	C	7	8-1	8888	41	12	22	1124		3F4	#	1F2	*	2114

LL Format of Rotated Assembly  
(for standardized apart-code)

	Cnt	Uni	PM	L	H	Lvs	LTyp	Asm	Sol	St	Move1	Move2	Move3	Ap Move
55541131100342221133100342006664	867	125	9	C	6	8-1	8888	21	1	16	1124	3F4	1F2	212
54541135102042220633000640066664	9	0	10	6	8	8-1	8000	6	4	11	1124	3F4	1F2	316
55541133102242220630000642026664	30	0	10	C	7	8-1	7888	34	8	17	1124	3F4	1F2	326
55541135102242226630000642026664	24	4	10	6	6	8-1	8000	24	1	10	1124	3F4	1F2	326
35541135500542220630000642026664	8	0	9	C	8	8-1	5788	46	20	17	1124	3F4	1F2	326
55541133102242226630000642026664	48	0	9	6	6	8-1	8000	21	3	13	1124	3F4	1F2	326
54541135102242220630000642026664	6	0	11	8	7	8-1	6800	27	12	14	1124	3F4	1F2	326
54541135102242226136000642006664	54	0	10	8	6	8-1	5800	9	4	11	1124	3F4	1F2	3D6
54541135502242226136000642006664	180	16	9	8	6	8-1	5800	8	1	15	1124	3F4	1F2	3D6
55541135102242226636100642006464	294	83	10	6	5	8-1	8000	9	1	10	1124	3F4	1F2	3E6
55541131102242226636100642006464	558	200	9	6	5	8-1	8000	15	1	13	1124	3F4	1F2	3E6
54541135100542226136002040066664	30	12	9	6	7	8-2	8000	1	1	10	1124	3F4	1F2	3E6
54551531400240221133400662226460	142	16	10	C	6	8-1	8888	3	1	10	11246	216	1F2	313
35550513010244221103600624623666	32	21	13	C	6	8-2	8888	6	1	8	11246	3135	1115	3F5
35550513010244221113600224603636	6	2	12	6	6	8-4	8000	1	1	8	11246	3135	1115	3F5
35550513010044051103600624223666	1	0	13	C	8	8-1	8888	10	3	10	11246	3135	1115	3F5
35550503010044051113600624223666	1	0	12	C	8	8-2	8888	10	2	10	11246	3135	1115	3F5
50501130010554221133440344626060	294	0	10	6	8	8-1	8000	28	9	10	1126	21146	1F2	313
54501135440554226033110344666060	228	19	12	C	6	8-1	8888	10	1	14	1126	21146	1F2	313
50501130110554221133410344626060	295	3	10	6	7	8-1	8000	4	1	9	1126	21146	1F2	313
50545533540044221133110344626060	56	4	10	6	6	8-1	8000	6	1	18	1126	21146	1F2	313
54501130000554221133140344666060	85	0	9	6	8	8-1	8000	36	22	13	1126	2146	1F2	313
55555530040050021131442602226060	6	0	10	6	9	8-2	8000	42	17	14	1126	325	1F2	* 1F26
55550030042052021136042602226060	45	0	12	C	10	8-1	3588	200	178	18	1126	325	1F2	* 1F26
54555011403520221111403620006464	19	0	8	C	7	8-1	6888	7	5	14	114	314	1F1	* 2124
54551033403320221113403620006464	353	4	9	C	7	8-1	4888	10	1	16	114	314	1F1	* 2124
54551033403050221116403660006436	9	0	10	C	8	8-1	4888	61	18	23	114	314	1F1	* 2124
54551115403320221016403000066466	4	0	8	C	8	8-1	4888	48	10	17	114	314	1F1	3E6
54551133402350221036400000066466	2	0	8	8	9	8-1	4800	33	8	17	114	314	1F1	3E6
54551115403550221036403000006466	8	0	9	C	9	8-1	4588	152	73	34	114	314	1F1	3E6
54541133403220521033402260066464	367	48	7	C	6	8-1	4888	10	1	12	114	314	* 1F1	* 3F6
54551110403350226016403300066464	9	0	9	C	8	8-2	6888	35	16	16	114	314	* 1F1	* 3F6
54555135403520221116403620006464	262	6	10	C	6	8-1	5888	3	1	10	114	314	2124	3D5
54541513403020221133403620006464	124	4	9	C	7	8-1	6888	9	1	19	114	314	2124	3E5
54541533403020221116403300006466	10	1	9	C	8	8-1	6888	5	1	20	114	314	2124	3E5
54555110403320221116403620006464	6	0	8	C	7	8-1	6888	14	6	15	114	314	2124	3F5
54551533403320221113403620006464	697	20	9	C	6	8-1	6888	2	1	10	114	314	2124	3F5
54555533403050221116403660006436	9	0	10	C	7	8-1	5888	15	6	14	114	314	2124	3F5
54545130403550221116403660006466	32	0	10	C	7	8-1	8888	16	7	12	114	314	2124	3F5
54555130403320221116403620006464	30	3	9	C	7	8-1	6888	11	1	13	114	314	2124	3F5
54541133403220521633402260066464	543	126	7	C	5	8-1	8888	9	1	9	114	314	* 3F6	* 1F1
54551110403320226616403300066464	9	0	9	C	7	8-1	7888	21	13	15	114	314	* 3F6	* 1F1
54551133403220226633403260066464	709	43	8	C	5	8-1	8888	5	1	19	114	314	* 3F6	* 211
54551133402222050633402222666464	539	308	9	6	4	8-3	8000	1	1	10	114	316	112	* 1125
54551133400052220633402222666464	44	24	9	8	5	8-3	5800	3	1	12	114	316	122	* 1125
54551111403000220631403302666460	12	4	7	6	8	8-1	8000	10	1	13	114	* 316	1F2	* 212
54351115403550220036403000266466	102	1	7	8	8	8-1	4800	32	1	17	114	* 316	1F2	* 326
54541131403550220036402000266464	2	0	7	6	8	8-1	8000	28	16	16	114	* 316	1F2	* 326
54551115403502220036403000266466	2	2	8	6	8	8-2	8000	20	1	23	114	* 316	1F2	* 326
55541103513340220600013340266464	2	0	8	6	7	8-2	8000	31	10	20	114	326	111	3F4
54350015403500521101403240226466	2	0	9	6	8	8-1	8000	15	2	15	1146	2F3	335	115
54350035403500521131403222226466	142	0	9	6	6	8-1	8000	9	3	14	1146	2F3	335	115
54505533402252551136400600226466	59	44	11	C	6	8-1	5888	2	1	20	1146	2F35	115	* 1F2
54501133402350251133400022226466	21	3	11	8	6	8-1	5800	1	1	21	1146	2F35	115	* 1F2
54505533402350551133400022226466	12	11	12	8	6	8-1	5800	6	1	15	1146	2F35	115	* 1F2

50341535512540521131400240226664	210	101	11	C	5	8-1	8888	3	1	13	1146	2F35	115	213
30545535512540251131400240226664	2992	1824	11	C	5	8-1	8888	1	1	12	1146	2F35	115	213
54505533402252551131400660226464	366	206	10	C	5	8-1	7888	29	1	13	1146	2F35	115	213
54505533402250051136400222606466	12	9	10	C	7	8-1	7888	1	1	17	1146	2F35	115	213
54505533402250051131400640226466	27	9	11	C	7	8-1	7888	1	1	17	1146	2F35	115	213
54505533402552221131400040026466	24	0	10	C	7	8-1	6788	14	2	14	1146	2F35	115	213
54505533402350551136400220226466	188	28	10	C	6	8-1	7888	13	1	18	1146	2F35	115	213
54501135403350551131400222226466	1199	166	10	8	5	8-1	7800	6	1	14	1146	2F35	115	213
54501535403350551131400222226466	713	322	11	8	5	8-1	7800	3	1	13	1146	2F35	115	213
54501533403552221131400202206466	28	3	9	C	6	8-1	7888	31	1	15	1146	2F35	115	213
54505533400350251131400220226466	8	3	11	C	7	8-1	7888	23	1	22	1146	2F35	115	213
54505135403350551101403260226466	343	7	10	8	6	8-1	8800	13	1	13	1146	2F35	115	213
54505535403350551133403260226466	714	284	10	6	5	8-1	8000	5	1	12	1146	2F35	115	213
54505533402250551136400260226466	7	6	11	C	6	8-1	7888	26	1	20	1146	2F35	115	213

LL Format of Rotated Assembly  
(for standardized apart-code)

	Cnt	Uni	PM	L	H	Lvs	LTyp	Asm	Sol	St	Move1	Move2	Move3	Ap Move
54505533400350251131400260226466	4	0	11	C	7	8-1	8888	34	3	16	1146	2F35	115	213
54505533403550551131403220226466	1068	191	12	C	5	8-1	8888	9	1	12	1146	2F35	115	213
54505533403250251131403660226464	630	124	12	C	5	8-1	8888	18	1	13	1146	2F35	115	213
54505533400352551131400640226466	250	37	9	C	6	8-1	8888	11	1	16	1146	2F35	115	213
54551133402520021133400002226466	8	0	11	C	7	8-1	4588	7	4	25	1146	2F35	1E2	2135
34555035402520221133400002226466	4	0	12	C	7	8-1	4588	6	3	25	1146	2F35	1E2	2135
54551133402520221136400002226466	57	0	12	C	6	8-3	4588	6	2	24	1146	2F35	1E2	2135
54550533400502251131400022226466	10	0	10	C	7	8-1	6888	20	10	13	1146	2F35	1F2	* 315
54541530403350551131400022226466	8	3	11	6	6	8-1	8000	4	1	20	1146	2F35	1F2	* 325
54551500403340521101103640226664	22	1	11	6	7	8-1	8000	48	1	14	1146	2F35	325	2135
54550030403350221136400202206466	4	0	11	C	9	8-2	4788	132	44	29	1146	2F35	325	2135
55541510003340551106013340226664	7	2	12	6	7	8-1	8000	1	1	16	1146	2F35	325	2135
54551530403350551131403360226466	146	27	11	6	5	8-1	8000	3	1	17	1146	2F35	325	2135
54551530403350551131400602226466	9	4	12	6	6	8-2	8000	8	1	12	1146	2F35	325	2135
54541530403350551131403660226464	258	47	11	6	5	8-1	8000	4	1	12	1146	2F35	325	2135
55541130002340251133100340226664	657	5	10	6	7	8-1	8000	9	1	17	1146	2F35	325	2135
55541530003340551131103640226664	54	2	10	6	6	8-1	8000	8	1	12	1146	2F35	325	2135
55541131510040200033400640226664	2	0	9	6	9	8-1	8000	60	34	16	1146	313	1115	211
50541531510240221133400340606664	42	4	9	C	7	8-1	6888	3	1	15	1146	313	1115	2F5
50541531510540501133600640226664	4	0	10	C	7	8-1	6888	20	5	19	1146	313	1115	2F5
54550533403200251133400002226466	2	0	12	A	8	8-1	3580	7	3	26	1146	315	* 2F35	* 1E2
50501131140002221130443200226060	14	0	8	C	10	8-1	5888	240	160	36	1156	213	1E2	2D3
50501131140002221131443200226060	18	0	10	C	9	8-1	6888	240	143	32	1156	213	1E2	2E3
30305115403544551116013224226060	129	2	13	C	6	8-1	8888	7	1	12	116	21246	1115	2113
30305115003524521116013224226060	27	0	12	C	7	8-1	8888	29	9	15	116	21246	1115	2113
50541110003342521100143244226060	381	4	12	8	8	8-1	6800	7	1	13	116	21246	121	2F24
50541131143200226033040002226060	3	0	12	6	10	8-1	8000	36	34	25	116	21246	1E2	2F24
50541131143200220033140002226060	5	0	13	8	10	8-2	8800	96	76	19	116	21246	1E2	2F24
50541131143202220033140002226060	16	0	12	6	9	8-2	8000	96	64	12	116	21246	1E2	2F24
30305015143542551131143244226060	144	0	11	C	5	8-1	8888	4	4	23	116	21246	3F1	1115
55541131043540226036042602603030	16	0	7	C	8	8-1	8888	11	8	12	116	216	* 1F2	# 2F3
55541131543540226036042602603030	48	0	7	C	7	8-1	8888	10	5	11	116	216	* 1F2	# 2F3
54501135543200226036040602603000	1	0	8	8	11	8-1	6800	17	15	17	116	216	* 2F3	* 1E2
35550533043044221136043660606034	80	5	8	6	7	8-1	8000	1	1	10	116	2E3	# 315	2F3
05550031113354001136043604226060	12	0	8	6	9	8-1	8000	248	134	22	116	* 2F2	* 3125	* 2E3

35351131002354001100013344226060	23	0	13	C	9	8-1	6888	47	14	12	116	2F23	1E1	2123
35355135043300001136042222606060	44	0	8	6	9	8-1	8000	19	12	14	116	2F23	312	213
54555031443000001131042222606060	4	0	9	C	10	8-1	7788	18	8	13	116	2F23	312	213
55541131543000006031042222606060	1	0	8	6	10	8-1	8000	40	24	13	116	2F23	312	213
54555031043000001131442222606060	2	0	9	C	10	8-1	7788	14	6	13	116	2F23	312	213
55351131542300001131142222606060	785	0	10	C	7	8-1	8888	25	12	13	116	2F23	312	213
55351135442300001130142222606060	152	0	9	C	8	8-2	5888	33	20	18	116	2F23	312	213
35351135543300001136042222606060	382	0	9	C	8	8-2	8888	23	10	14	116	2F23	312	213
55351135143300000136042222606060	8	0	8	C	9	8-1	7788	50	27	18	116	2F23	312	213
55351135143300000130142222606060	19	0	8	C	9	8-1	5888	78	48	15	116	2F23	312	213
55541131143220220030140000226060	78	0	8	8	10	8-2	3800	372	196	19	116	2F3	1D2	# 213
54550035143220221130140000226060	92	0	9	8	10	8-1	3800	420	244	16	116	2F3	# 1D2	# 213
55541135143220220031140000226060	306	0	8	8	9	8-2	5800	432	137	13	116	2F3	# 1D2	# 213
54551135443200220036040002226060	2	0	8	6	10	8-1	8000	192	118	27	116	2F3	1E2	213
55541130443200220033440002226060	58	0	9	6	10	8-1	8000	104	72	17	116	2F3	1E2	213
54551131443200226031440002226060	162	2	8	6	8	8-2	8000	14	1	16	116	2F3	1E2	213
54551130143200221136040002226060	12	0	8	6	9	8-1	8000	56	19	17	116	2F3	1E2	213
55541131143200226031040002226060	14	0	8	6	9	8-1	8000	10	5	14	116	2F3	# 1E2	213
55545535543200221136040002226060	171	0	8	6	8	8-2	8000	48	30	14	116	2F3	# 1E2	213
54550035143200221130140002226060	17	0	10	8	10	8-1	3800	228	89	14	116	2F3	# 1E2	213
35355133143200221133440002226060	162	0	12	8	7	8-1	3800	19	8	14	116	2F3	1E2	213
35351533443200221133140002226060	87	0	11	8	7	8-1	3800	19	4	17	116	2F3	1E2	213
54551130143200221133140002226060	30	0	8	6	8	8-1	8000	72	27	13	116	2F3	1E2	213
54541135143200220031140002226060	95	0	9	8	9	8-2	8800	176	96	18	116	2F3	# 1E2	213
55351131443202200030440002226060	150	0	8	C	10	8-1	3888	211	95	13	116	2F3	1E2	213
55541130143202220033140002226060	32	0	8	6	9	8-1	8000	144	60	15	116	2F3	1E2	213
35051533443200221133140002226060	111	0	10	C	8	8-1	3888	19	7	19	116	2F3	1E2	213
35051533443202221136040002226060	6	0	9	6	8	8-1	8000	13	5	21	116	2F3	1E2	213
35355033143200221133140002226060	29	0	8	C	8	8-1	3688	27	8	17	116	2F3	1E2	213
54540030443202221131140002226060	10	0	9	6	9	8-2	8000	96	92	13	116	2F3	* 1E2	213
35355133443202221136040002226060	403	0	11	6	7	8-1	8000	17	5	12	116	2F3	1E2	213
35355130443202221131140002226060	331	0	10	6	7	8-1	8000	26	16	13	116	2F3	1E2	213
05350531443202221131140002226060	20	0	9	6	8	8-1	8000	40	26	17	116	2F3	1E2	213
35351533543200221133440002226060	666	45	11	C	7	8-1	3888	20	1	15	116	2F3	1E2	213

LL Format of Rotated Assembly  
(for standardized apart-code)

	Cnt	Uni	PM	L	H	Lvs	LTyp	Asm	Sol	St	Move1	Move2	Move3	Ap Move
35351133143200226033140002226060	24	0	9	C	8	8-1	4688	12	6	16	116	2F3	1E2	213
35351131443200221131140002226060	561	0	11	C	7	8-1	7888	52	21	14	116	2F3	# 1E2	213
55541131543202220031140002226060	46	0	8	6	8	8-2	8000	232	73	11	116	2F3	# 1E2	213
35055533443202221131440002226060	40	0	10	6	7	8-1	8000	40	23	11	116	2F3	1E2	213
35351131443202201131140002226060	63	0	9	6	7	8-1	8000	52	21	12	116	2F3	1E2	213
35351131543202220031440002226060	49	0	8	6	8	8-1	8000	166	76	12	116	2F3	1E2	213
35550030043044551136603344226060	187	0	9	8	8	8-1	4800	100	22	22	116	2F3	315	* 2E3
30500530513054251136043324226060	75	3	8	8	8	8-1	6800	14	1	18	116	2F3	315	2E3
35355035040344251131440660226060	6	0	10	C	7	8-1	7888	12	5	13	116	2F3	315	2F2
35550010043044551106043344226060	71	0	9	8	9	8-1	5800	69	45	17	116	2F3	315	# 2F2
35555010043244551106013244226060	570	27	9	6	7	8-1	8000	4	1	10	116	2F3	315	# 2F2
35550035013504521100403244226060	14	0	7	6	9	8-1	8000	112	50	20	116	2F3	335	1F1
35555000013504521101413044226060	16	0	8	6	9	8-1	8000	29	8	15	116	2F3	335	213
00305135142544521131140602226060	127	14	10	C	7	8-1	8888	10	1	14	116	2F35	115	213
30305535142522521133140602226060	1238	60	10	C	6	8-1	8888	20	1	14	116	2F35	115	213

30305535442542521131140602226060	321	9	9	C	6	8-1	8888	6	1	13	116	2F35	115	213
30005535142504521133140222226060	120	0	9	6	7	8-1	8000	8	2	16	116	2F35	115	213
30305135442504521136040022226060	396	2	10	C	8	8-1	6888	10	1	16	116	2F35	115	213
30305535142522521131140004226060	108	0	10	C	7	8-1	6688	15	3	17	116	2F35	115	213
30305135142504551131140022226060	216	0	9	C	7	8-1	6888	11	4	17	116	2F35	115	213
54540033443220221133140000226060	35	0	11	8	9	8-1	3800	128	118	15	116	2F35	1D2	2135
54541133143220220031140000226060	21	0	10	8	9	8-2	4800	176	127	15	116	2F35	# 1D2	# 2135
50501133442520221131140002026060	28	0	10	C	9	8-1	4888	58	12	18	116	2F35	1E2	2135
50541135543200226033040002226060	3	0	10	6	10	8-1	8000	41	31	26	116	2F35	* 1E2	2135
50541533543200221136040002226060	2	0	10	6	9	8-2	8000	68	19	24	116	2F35	* 1E2	2135
54541133143200220031140002226060	4	0	11	8	9	8-2	8800	96	61	16	116	2F35	# 1E2	2135
54540030442520221131140002226060	12	0	11	6	9	8-2	8000	58	55	12	116	2F35	1E2	2135
54541133143202220031140002226060	43	0	10	6	8	8-2	8000	96	55	12	116	2F35	# 1E2	2135
50501131443520021131140002226060	30	0	9	C	9	8-1	8888	176	102	14	116	2F35	1E2	215
50545135543322221130440040026060	65	0	8	6	8	8-1	8000	64	23	20	116	2F35	1F2	313
05051131010224220033040344606060	4	0	8	C	11	8-1	4888	118	110	20	116	313	111	211
35051131040244250033010604226060	50	0	9	C	10	8-2	8888	94	48	9	116	313	111	211
35051113012044250033440604226060	8	0	10	C	9	8-1	8888	12	7	9	116	313	111	211
35051113042044250033010604226060	4	0	9	C	10	8-1	8888	47	33	10	116	313	111	211
55550130510004501133010604226060	6	0	8	C	11	8-1	7788	198	178	19	116	313	111	3E5
55550130510004501133110604226060	6	0	9	C	10	8-1	7788	174	140	17	116	313	111	3E5
05055135140054221131142002003666	126	0	8	6	8	8-2	8000	27	2	18	122	213	1F6	2F4

Table 9 - Results of the 542 Cases

Case	Ornt	---Bit-Codes---	ASM-Count	N	User	Level-8	Level9	Lvl10	12	Case	Ornt	---Bit-Codes---	A
1	2	0111 1111 11 11	187044	G	BCP1					71	282	0001 0111 11 11	
2	6	1011 1111 11 11	184177	G	BCP1					72	286	0010 0111 11 11	
3	10	1111 1111 01 11	187044	G	BCP1					73	290	0100 0111 11 11	
4	14	0011 1111 11 11	698023	G	BCP1					74	294	1000 0111 11 11	
5	18	0101 1111 11 11	657070	G	BCP1					75	298	0001 1011 11 11	
6	22	1011 0111 11 11	657070	G	BCP1					76	302	0010 1011 11 11	
7	26	1101 0111 11 11	657070	G	BCP1					77	306	0100 1011 11 11	
8	30	0111 1111 01 11	655943	G	BCP1					78	310	1000 1011 11 11	
9	34	1011 1111 01 11	657070	G	BCP1					79	314	0101 0011 11 11	
10	38	1101 1111 01 11	657070	G	BCP1					80	318	1001 0011 11 11	
11	42	1110 1111 01 11	655943	G	BCP1					81	322	0110 0011 11 11	
12	46	1111 0111 01 11	655943	G	BCP1					82	326	1010 0011 11 11	
13	50	1111 1011 01 11	706117	N	BCP1					83	330	1001 0101 11 11	
14	54	1111 1101 01 11	657070	G	BCP1					84	334	0110 0101 11 11	
15	58	1111 1110 01 11	655943	G	BCP1					85	338	0001 1111 01 11	
16	62	0001 1111 11 11	2443110	G	BCP1					86	342	0010 1111 01 11	
17	66	0010 1111 11 11	2224952	G	BCP1					87	346	0100 1111 01 11	
18	70	0011 0111 11 11	5536579	G	MIS1					88	350	1000 1111 01 11	
19	74	0101 0111 11 11	4683171	G	BCP1					89	354	0011 0111 01 11	
20	78	1001 0111 11 11	2285234	G	BCP1					90	358	0101 0111 01 11	
21	82	0110 0111 11 11	4617754	G	BCP1					91	362	1001 0111 01 11	
22	86	1010 0111 11 11	2063189	G	BCP1					92	366	0110 0111 01 11	
23	90	1100 0111 11 11	2224950	G	BCP1					93	370	1010 0111 01 11	
24	94	0011 1011 11 11	2564895	G	BCP1					94	374	1100 0111 01 11	
25	98	0101 1011 11 11	2099234	G	BCP1					95	378	0011 1011 01 11	
26	102	1001 1011 11 11	2469972	G	BCP2					96	382	0101 1011 01 11	
27	106	0110 1011 11 11	2063189	G	BCP2					97	386	1001 1011 01 11	
28	110	1010 1011 11 11	2251374	G	BCP2					98	390	0110 1011 01 11	
29	114	1100 1011 11 11	2259599	G	BCP2					99	394	1010 1011 01 11	
30	118	0011 1111 01 11	2224948	G	BCP2					100	398	1100 1011 01 11	
31	122	0101 1111 01 11	2063187	G	BCP2					101	402	0111 0011 01 11	
32	126	1001 1111 01 11	2285228	G	BCP2					102	406	1011 0011 01 11	
33	130	0110 1111 01 11	2023702	G	BCP2					103	410	1101 0011 01 11	
34	134	1010 1111 01 11	2063187	G	BCP2					104	414	1110 0011 01 11	
35	138	1100 1111 01 11	2224948	G	BCP2					105	418	0011 1101 01 11	
36	142	0111 0111 01 11	4617734	G	BCP2					106	422	0101 1101 01 11	
37	146	1011 0111 01 11	2063187	G	BCP2					107	426	1001 1101 01 11	
38	150	1101 0111 01 11	2063187	G	BCP2					108	430	0110 1101 01 11	
39	154	1110 0111 01 11	2023702	G	BCP2					109	434	1010 1101 01 11	
40	158	0111 1011 01 11	2252063	G	BCP2					110	438	1100 1101 01 11	
41	162	1011 1011 01 11	2437309	N	BCP1					111	442	0111 0101 01 11	
42	166	1101 1011 01 11	2285480	G	BCP2					112	446	1101 0101 01 11	
43	170	1110 1011 01 11	2252063	G	BCP2					113	450	1110 0101 01 11	
44	174	1111 0011 01 11	2413812	G	BCP2					114	454	0111 1001 01 11	
45	178	0111 1101 01 11	2063175	G	BCP2					115	458	1011 1001 01 11	
46	182	1011 1101 01 11	2099220	G	BCP2					116	462	1101 1001 01 11	
47	186	1101 1101 01 11	2251360	G	BCP2					117	466	1110 1001 01 11	
48	190	1110 1101 01 11	2063165	G	BCP2					118	470	1111 0001 01 11	
49	194	1111 0101 01 11	2063173	G	BCP2					119	474	0011 1110 01 11	
50	198	1111 1001 01 11	2482110	G	BCP2					120	478	0101 1110 01 11	
51	202	0111 1110 01 11	2023698	G	HLN1					121	482	1001 1110 01 11	
52	206	1011 1110 01 11	2063185	G	HLN1					122	486	0110 1110 01 11	
53	210	1101 1110 01 11	2063175	G	HLN1					123	490	1010 1110 01 11	
54	214	1110 1110 01 11	4617722	G	HLN1					124	494	1100 1110 01 11	

55	218	1111	0110	01	11	2023698	G	HLN1						125	498	0111	0110	01	11
56	222	1111	1010	01	11	2252059	G	HLN1						126	502	1011	0110	01	11
57	226	1111	1100	01	11	2224918	G	HLN1						127	506	1101	0110	01	11
58	230	0111	1111	00	11	2023682	G	HLN1						128	510	1110	0110	01	11
59	234	1011	1111	00	11	2063169	G	HLN1						129	514	0111	1010	01	11
60	238	1111	0111	00	11	2023682	G	HLN1						130	518	1011	1010	01	11
61	242	1111	1011	00	11	2251973	G	BCP2						131	522	1101	1010	01	11
62	246	0111	1111	01	01	2023698	G	BCP2						132	526	1110	1010	01	11
63	250	1011	1111	01	01	2252055	N	BCP2						133	530	1111	0010	01	11
64	254	1101	1111	01	01	2063167	G	BCP2						134	534	0111	1100	01	11
65	258	1110	1111	01	01	2023698	G	BCP2						135	538	1011	1100	01	11
66	262	0111	1111	10	01	2023698	G	BCP2						136	542	1101	1100	01	11
67	266	1011	1111	10	01	2252055	G	BCP2						137	546	1110	1100	01	11
68	270	1101	1111	10	01	2063167	G	BCP2						138	550	1111	0100	01	11
69	274	1110	1111	10	01	2023698	G	BCP2						139	554	1111	1000	01	11
70	278	1111	1111	00	01	2023682	G	BCP2						140	558	0011	1111	00	11

Ornt - Orientation Number

N - Notchable

User - Who Ran Case

U in Level 8,9

Case	Ornt	---Bit-Codes---	ASM-Count	N	User	Level-8	Level9	Lvl10	12	Case	Ornt	---Bit-Codes---	A
141	562	0101 1111 00 11	5840326	G	MVL1					211	842	0100 1101 01 11	
142	566	0111 0111 00 11	13155859	G	MVL1	2				212	846	1000 1101 01 11	
143	570	1011 0111 00 11	5837507	G	MVL1					213	850	0101 0101 01 11	
144	574	1101 0111 00 11	5840326	G	MVL1					214	854	0110 0101 01 11	
145	578	1110 0111 00 11	5633871	G	MVL1					215	858	1100 0101 01 11	
146	582	0111 1011 00 11	6446559	G	MVL1					216	862	0011 1001 01 11	
147	586	1011 1011 00 11	7193053	G	MVL1	19U4				217	866	0101 1001 01 11	
148	590	1101 1011 00 11	6651225	G	MVL1	29U4	9U1			218	870	1001 1001 01 11	
149	594	1110 1011 00 11	6448006	G	MVL1					219	874	0110 1001 01 11	
150	598	1111 0011 00 11	6990454	G	MVL1					220	878	1010 1001 01 11	
151	602	1111 0101 00 11	6447332	G	BCP2					221	882	1100 1001 01 11	
152	606	0011 1111 01 01	7003361	G	BCP2	1U1				222	886	0111 0001 01 11	
153	610	0101 1111 01 01	5838690	G	BCP2					223	890	1011 0001 01 11	
154	614	1001 1111 01 01	7314410	G	BCP2	2				224	894	1101 0001 01 11	
155	618	0110 1111 01 01	5636855	G	BCP2					225	898	1110 0001 01 11	
156	622	1010 1111 01 01	6460513	G	BCP2					226	902	0001 1110 01 11	
157	626	1100 1111 01 01	6381028	G	BCP2	1U1				227	906	0010 1110 01 11	
158	630	1101 0111 01 01	5838512	G	BCP2					228	910	0100 1110 01 11	
159	634	1110 0111 01 01	5636855	G	BCP2					229	914	1000 1110 01 11	
160	638	1110 1011 01 01	6460338	G	BCP2					230	918	0011 0110 01 11	
161	642	1110 1101 01 01	5835001	G	BCP2					231	922	0101 0110 01 11	
162	646	0011 1111 10 01	7002335	G	BCP2	1U1				232	926	1001 0110 01 11	
163	650	0101 1111 10 01	5838337	G	BCP2					233	930	0110 0110 01 11	
164	654	1001 1111 10 01	7312543	G	BCP2	2U1				234	934	1010 0110 01 11	
165	658	0110 1111 10 01	5636505	G	BCP2					235	938	1100 0110 01 11	
166	662	1010 1111 10 01	6459982	G	BCP2					236	942	0011 1010 01 11	
167	666	1100 1111 10 01	6380179	G	BCP2	1U1				237	946	0101 1010 01 11	
168	670	0111 0111 10 01	13161772	G	BCP2					238	950	1001 1010 01 11	
169	674	1011 0111 10 01	6456157	G	BCP2					239	954	0110 1010 01 11	
170	678	1101 0111 10 01	5837984	G	BCP2					240	958	1010 1010 01 11	
171	682	0111 1101 10 01	6459807	G	BCP2					241	962	1100 1010 01 11	
172	686	0111 1111 00 01	5632797	G	BCP2	1U1				242	966	0111 0010 01 11	
173	690	1011 1111 00 01	6456350	G	BCP2	1U1				243	970	1011 0010 01 11	
174	694	1101 1111 00 01	5834563	G	BCP2	1U1				244	974	1101 0010 01 11	

175	698	1110	1111	00	01	5632797	G	BCP2	1U1					245	978	1110	0010	01	11
176	702	1111	0111	00	01	5632797	G	BCP2	2U1					246	982	0011	1100	01	11
177	706	1111	1011	00	01	6443339	G	BCP2	1U1					247	986	0101	1100	01	11
178	710	1111	1101	00	01	6442989	N	BCP2	1U1					248	990	1001	1100	01	11
179	714	1111	1110	00	01	5632797	G	BCP2	2U2					249	994	0110	1100	01	11
180	718	0000	0111	11	11	54201118	G	MIS1	5					250	998	1010	1100	01	11
181	722	0000	1011	11	11	25770221	G	HLN1	171U14					251	1002	1100	1100	01	11
182	726	0001	0011	11	11	66162338	G	HLN1	2U1					252	1006	0111	0100	01	11
183	730	0010	0011	11	11	58805776	G	HLN1	4					253	1010	1101	0100	01	11
184	734	0100	0011	11	11	49865369	G	HLN1	2					254	1014	1110	0100	01	11
185	738	1000	0011	11	11	26088528	G	HLN1	173U13					255	1018	0111	1000	01	11
186	742	0001	0101	11	11	56206370	G	GRV1	303	186U1	26	1		256	1022	1011	1000	01	11
187	746	0010	0101	11	11	45253244	G	GRV1						257	1026	1101	1000	01	11
188	750	0100	0101	11	11	48767835	G	GRV1	2					258	1030	1110	1000	01	11
189	754	1000	0101	11	11	23637111	G	GRV1	164					259	1034	1111	0000	01	11
190	758	0001	1001	11	11	29178057	G	GRV1	303					260	1038	0001	1111	00	11
191	762	0010	1001	11	11	23960559	G	GRV1	17U14					261	1042	0010	1111	00	11
192	766	0110	0001	11	11	49406686	G	GRV1	0	3				262	1046	0011	0111	00	11
193	770	0010	0110	11	11	103422229	G	GRV1	641U7	43	13			263	1050	0101	0111	00	11
194	774	0000	1111	01	11	21145127	G	GRV1	1					264	1054	1001	0111	00	11
195	778	0001	0111	01	11	49241489	G	GRV1	7U3					265	1058	0110	0111	00	11
196	782	0010	0111	01	11	43290016	G	GRV1	2U2					266	1062	1010	0111	00	11
197	786	0100	0111	01	11	39340925	G	GRV1	2					267	1066	1100	0111	00	11
198	790	1000	0111	01	11	19361339	G	GRV1	1U1					268	1070	0011	1011	00	11
199	794	0001	1011	01	11	25680950	G	GRV1	115U18					269	1074	0101	1011	00	11
200	798	0010	1011	01	11	22719278	G	GRV1	14U11					270	1078	1001	1011	00	11
201	802	0100	1011	01	11	19457851	G	HLN1	1U1					271	1082	0110	1011	00	11
202	806	1000	1011	01	11	24249009	G	HLN1	185U13	15U1				272	1086	1010	1011	00	11
203	810	0011	0011	01	11	63175141	N	JWN1	8U1					273	1090	1100	1011	00	11
204	814	0101	0011	01	11	49159460	G	HLN1	4					274	1094	0111	0011	00	11
205	818	1001	0011	01	11	25807625	G	HLN1	2					275	1098	1011	0011	00	11
206	822	0110	0011	01	11	47344660	G	HLN1	4					276	1102	1101	0011	00	11
207	826	1010	0011	01	11	22509459	G	HLN1	6					277	1106	1110	0011	00	11
208	830	1100	0011	01	11	21144765	G	HLN1						278	1110	0111	0101	00	11
209	834	0001	1101	01	11	21983219	G	HLN1	158U7					279	1114	1101	0101	00	11
210	838	0010	1101	01	11	17392301	G	HLN1	1U1					280	1118	1110	0101	00	11

Ornt - Orientation Number      N - Notchable      User - Who Ran Case      U in Level 8,9

Case	Ornt	---Bit-Codes---	ASM-Count	N	User	Level-8	Level9	Lvl10	12	Case	Ornt	---Bit-Codes---	A
281	1122	0111 1001 00 11	19882151	G	MVL1					351	1402	0011 0001 01 11 1	
282	1126	1011 1001 00 11	22631767	N	JWN1					352	1406	0101 0001 01 11 1	
283	1130	1111 0001 00 11	21571706	G	HLN1					353	1410	1001 0001 01 11	
284	1134	0111 0110 00 11	32907105	G	HLN1	34	12			354	1414	0110 0001 01 11 1	
285	1138	1011 0110 00 11	14591650	G	HLN1					355	1418	1010 0001 01 11	
286	1142	1111 0010 00 11	17652624	G	HLN1					356	1422	1100 0001 01 11	
287	1146	0001 1111 01 01	20314984	G	HLN1	4U2				357	1426	0000 1110 01 11 1	
288	1150	0010 1111 01 01	17954681	G	HLN1	2U2				358	1430	0001 0110 01 11 1	
289	1154	0100 1111 01 01	16174697	G	HLN1	2U2				359	1434	0010 0110 01 11 2	
290	1158	1000 1111 01 01	20443225	G	HLN1	4U1				360	1438	0100 0110 01 11 2	
291	1162	1100 0111 01 01	16168971	G	HLN1	1U1				361	1442	1000 0110 01 11 1	
292	1166	1110 0011 01 01	17933218	G	HLN1	1U1				362	1446	0001 1010 01 11	
293	1170	0110 1101 01 01	14566934	G	HLN1					363	1450	0010 1010 01 11 1	
294	1174	1110 0101 01 01	14560940	G	HLN1					364	1454	0100 1010 01 11 1	



295	1178	1110	1001	01	01	18656831	G	HLN1	3U2									365	1458	1000	1010	01	11	1
296	1182	0110	1110	01	01	33119294	G	HLN1										366	1462	0011	0010	01	11	1
297	1186	1010	1110	01	01	38375262	N	JWN1										367	1466	0101	0010	01	11	1
298	1190	1100	1110	01	01	41495246	G	HLN1	2U2									368	1470	1001	0010	01	11	
299	1194	0001	1111	10	01	20231924	G	HLN1	4U2									369	1474	0110	0010	01	11	2
300	1198	0010	1111	10	01	17902887	G	HLN1	2U2									370	1478	1010	0010	01	11	1
301	1202	0100	1111	10	01	16133197	G	HLN1	2U2									371	1482	1100	0010	01	11	1
302	1206	1000	1111	10	01	20358837	G	HLN1	4U4									372	1486	0001	1100	01	11	
303	1210	0011	0111	10	01	45701846	G	HLN1	2U2									373	1490	0010	1100	01	11	
304	1214	0101	0111	10	01	34248336	G	HLN1										374	1494	0100	1100	01	11	1
305	1218	1001	0111	10	01	18590271	G	HLN1	3U1									375	1498	1000	1100	01	11	1
306	1222	0110	0111	10	01	33040655	G	HLN1										376	1502	0101	0100	01	11	
307	1226	1010	0111	10	01	16276851	G	HLN1										377	1506	0110	0100	01	11	1
308	1230	1100	0111	10	01	16103443	G	HLN1	1U1									378	1510	1100	0100	01	11	1
309	1234	0110	1101	10	01	16270857	G	HLN1										379	1514	0011	1000	01	11	
310	1238	0111	0101	10	01	38269544	G	HLN1										380	1518	0101	1000	01	11	
311	1242	0011	1110	10	01	17853114	G	HLN1	1U1									381	1522	1001	1000	01	11	
312	1246	0110	1110	10	01	33023477	G	HLN1										382	1526	0110	1000	01	11	1
313	1250	0011	1111	00	01	17726595	G	HLN1	5U4									383	1530	1010	1000	01	11	1
314	1254	0101	1111	00	01	14488052	G	HLN1	2U2									384	1534	1100	1000	01	11	1
315	1258	1001	1111	00	01	18518830	G	HLN1	7									385	1538	0111	0000	01	11	1
316	1262	0110	1111	00	01	13903485	G	HLN1	2U2									386	1542	1011	0000	01	11	
317	1266	1010	1111	00	01	16241189	G	HLN1	2U1									387	1546	1101	0000	01	11	
318	1270	1100	1111	00	01	15964671	G	HLN1	5U4									388	1550	1110	0000	01	11	1
319	1274	1101	0111	00	01	14484854	G	HLN1	3U3									389	1554	0001	0111	00	11	
320	1278	1110	0111	00	01	13903485	G	HLN1	3U3									390	1558	0010	0111	00	11	
321	1282	1110	1011	00	01	15981457	G	HLN1	21U21									391	1562	0100	0111	00	11	
322	1286	1111	0011	00	01	17456650	G	HLN1	17U6									392	1566	1000	0111	00	11	
323	1290	0111	1101	00	01	15970285	G	HLN1	21U13									393	1570	0001	1011	00	11	
324	1294	1110	1101	00	01	15865548	G	HLN1	23U12									394	1574	0010	1011	00	11	
325	1298	1111	0101	00	01	15959113	G	HLN1	24U22									395	1578	0100	1011	00	11	
326	1302	1111	1001	00	01	19409895	N	JWN1										396	1582	1000	1011	00	11	
327	1306	0111	1110	00	01	13894761	G	MVL1	3U3									397	1586	0011	0011	00	11	1
328	1310	1011	1110	00	01	16210468	G	MVL1	3U3									398	1590	0101	0011	00	11	
329	1314	1110	1110	00	01	32714944	G	MVL1	4U2									399	1594	1001	0011	00	11	
330	1318	1111	0110	00	01	13894761	G	MVL1	4U3									400	1598	0110	0011	00	11	
331	1322	1111	1010	00	01	15933582	G	MVL1	24U22									401	1602	1010	0011	00	11	
332	1326	1111	1100	00	01	17409080	G	MVL1	17U14									402	1606	1100	0011	00	11	
333	1330	0111	1111	00	00	13777841	G	MVL1	10									403	1610	0101	0101	00	11	
334	1334	1011	1111	00	00	15808891	N	JWN1	21U2									404	1614	0110	0101	00	11	
335	1338	0000	0011	11	11	172350169	G	GRV1	30									405	1618	1100	0101	00	11	
336	1342	0000	0101	11	11	155608003	G	GRV1	128U19									406	1622	0011	1001	00	11	
337	1346	0010	0001	11	11	155202582	G	DRS1	157U12			1		1				407	1626	0101	1001	00	11	
338	1350	0100	0001	11	11	156610573	G	DRS1	1964U41			194U3		30				408	1630	0111	0001	00	11	
339	1354	0000	0111	01	11	125586552	G	DRS1	6									409	1634	1011	0001	00	11	
340	1358	0000	1011	01	11	66183754	G	DRS1	572U123			145U16						410	1638	1101	0001	00	11	
341	1362	0001	0011	01	11	167319735	G	HLN1	55			15U5						411	1642	1110	0001	00	11	
342	1366	0010	0011	01	11	145970423	G	HLN1	12U5									412	1646	0011	0110	00	11	
343	1370	0100	0011	01	11	124010733	G	HLN1	68U7			46						413	1650	0101	0110	00	11	
344	1374	1000	0011	01	11	65652230	G	HLN1	436U45			16U6						414	1654	0111	0010	00	11	
345	1378	0000	1101	01	11	58980842	G	HLN1	187U24									415	1658	1011	0010	00	11	
346	1382	0100	0101	01	11	108737383	G	HLN1	2									416	1662	1110	0010	00	11	
347	1386	0001	1001	01	11	73654903	G	HLN1	576U18			1						417	1666	0000	1111	01	01	
348	1390	0010	1001	01	11	58291579	G	HLN1	156U89									418	1670	1110	0001	01	01	
349	1394	0100	1001	01	11	59207546	G	HLN1	291U87									419	1674	0010	1110	01	01	
350	1398	1000	1001	01	11	73832217	G	HLN1	365U3			26U2		1				420	1678	0100	1110	01	01	

Ornt - Orientation Number

N - Notchable

User - Who Ran Case

U in Level 8,9

Case	Ornt	---Bit-Codes---	ASM-Count	N	User	Level-8	Level9	Lvl10	12	Case	Ornt	---Bit-Codes---	A
421	1682	1000 1110 01 01	88567930	G	HLN1	43U3				491	1962	1001 0001 00 11	
422	1686	1100 0110 01 01	71183911	G	HLN1	1U1				492	1966	0110 0001 00 11	
423	1690	0000 1111 10 01	38524643	G	HLN1	2				493	1970	1010 0001 00 11	
424	1694	0001 0111 10 01	86633115	G	HLN1	210U15				494	1974	1100 0001 00 11	
425	1698	0010 0111 10 01	79172914	G	HLN1	14U6				495	1978	0010 0110 00 11	
426	1702	0100 0111 10 01	64167619	G	HLN1	2				496	1982	0011 0010 00 11	
427	1706	1000 0111 10 01	34347876	G	HLN1	15U3				497	1986	0110 0010 00 11	
428	1710	0110 0101 10 01	64535541	G	HLN1					498	1990	1010 0010 00 11	
429	1714	0010 1110 10 01	71508951	G	HLN1	3				499	1994	0111 0000 00 11	
430	1718	0011 0110 10 01	78135866	G	HLN1	13U5				500	1998	1011 0000 00 11	
431	1722	0001 1111 00 01	33674740	G	GRV1	13U6				501	2002	0000 1110 01 01	
432	1726	0010 1111 00 01	30570515	G	MVL1	11U4				502	2006	0000 0111 10 01	
433	1730	0100 1111 00 01	27165928	G	MVL1	5U3				503	2010	0010 0110 10 01	
434	1734	1000 1111 00 01	33771915	G	MVL1	211U20				504	2014	0000 1111 00 01	
435	1738	1100 0111 00 01	27118267	G	MVL1	4U4				505	2018	1110 0001 00 01	
436	1742	1110 0011 00 01	29151370	G	MVL1	54U27				506	2022	0010 1110 00 01	
437	1746	0110 1101 00 01	26015287	G	MVL1	79U62				507	2026	1110 0010 00 01	
438	1750	1110 0101 00 01	25984233	G	MVL1	78U62				508	2030	0110 1100 00 01	
439	1754	1110 1001 00 01	30130864	G	MVL1					509	2034	1110 0100 00 01	
440	1758	1111 0001 00 01	33237773	G	MVL1					510	2038	1110 1000 00 01	
441	1762	0011 1110 00 01	30160829	G	MVL1	4U4				511	2042	1111 0000 00 01	
442	1766	0110 1110 00 01	54773283	G	MVL1	65U2	12			512	2046	0001 1111 00 00	
443	1770	1010 1110 00 01	62898525	G	MVL1	25U4	6			513	2050	0010 1111 00 00	
444	1774	1110 0110 00 01	54643498	G	MVL1	68U2	12			514	2054	1100 0111 00 00	
445	1778	1110 1010 00 01	59456993	G	MVL1	178U25	4			515	2058	0000 0001 01 11	
446	1782	1111 0010 00 01	28584412	G	MVL1	52U35				516	2062	0000 0010 01 11	
447	1786	0111 1100 00 01	28553358	G	MVL1	54U41				517	2066	0000 1000 01 11	
448	1790	1110 1100 00 01	71281818	N	JWN1	68U12				518	2070	0001 0000 01 11	
449	1794	1111 0100 00 01	28472664	G	GRV1	52U44				519	2074	0010 0000 01 11	
450	1798	1111 1000 00 01	31760041	G	GRV1					520	2078	0100 0000 01 11	
451	1802	0011 1111 00 00	27741829	G	GRV1	97U57				521	2082	1000 0000 01 11	
452	1806	0101 1111 00 00	25258928	G	MVL1	78U26				522	2086	0000 0011 00 11	
453	1810	1101 0111 00 00	25210656	G	MVL1	73U22				523	2090	0001 0001 00 11	
454	1814	0000 0001 11 11	294949284	G	DDB1	440U2	8			524	2094	0010 0001 00 11	
455	1818	0000 0010 11 11	507215581	G	JGS1	2308U91	207U14	25		525	2098	0100 0001 00 11	
456	1822	0000 0011 01 11	224566111	G	JGS1	426U7	110			526	2102	1000 0001 00 11	
457	1826	0000 1001 01 11	100223952	G	JGS1	869U97	56U6	1		527	2106	0010 0010 00 11	
458	1830	0001 0001 01 11	236733418	N	DDB1	1119U13	17U1			528	2110	0011 0000 00 11	
459	1834	0010 0001 01 11	175949339	G	JGS1	554U19	3			529	2114	0101 0000 00 11	
460	1838	0100 0001 01 11	173701463	G	JGS1	1543U70	250U5	28		530	2118	1110 0000 00 01	
461	1842	1000 0001 01 11	92827636	G	JGS1	836U11	33	2U1		531	2122	0000 0000 01 11	
462	1846	0000 0110 01 11	301342591	G	JBW1	3447U30	464U62	21U5		532	2126	0000 0001 00 11	
463	1850	0000 1010 01 11	159594295	G	JBW1	311U14	148			533	2130	0001 0000 00 11	
464	1854	0001 0010 01 11	162114875	G	JBW1	196U13	22U3			534	2134	0010 0000 00 11	
465	1858	0010 0010 01 11	283375442	N	DDB1	906U81	203U2			535		SYMMETRY CASE	
466	1862	0100 0010 01 11	250031973	G	JBW1	2708U76	187U10	5U1		536		SYMMETRY CASE	1
467	1866	1000 0010 01 11	130523410	G	JBW1	650U15	48			537		SYMMETRY CASE	
468	1870	0000 1100 01 11	123714952	G	JBW1	29				538		SYMMETRY CASE	
469	1874	0100 0100 01 11	204991920	G	GWP1	331U36	84			539		SYMMETRY CASE	
470	1878	0001 1000 01 11	59196586	G	GWP1	503U51	15U5	2		540		SYMMETRY CASE	
471	1882	0010 1000 01 11	105478867	G	GWP1	739U58	52U9	18		541		SYMMETRY CASE	
472	1886	0100 1000 01 11	107061914	G	GWP1	356U22	1	1		542		SYMMETRY CASE	
473	1890	1000 1000 01 11	140372815	N	JWN1	772U8	46U2	33					
474	1894	0011 0000 01 11	103605521	G	JGS1	322U6	62	1					
												Total Assemblies	205

475	1898	0101	0000	01	11	89233858	G	JGS1	166U20	65	3U2	
476	1902	1001	0000	01	11	50056656	G	MIS1	407U16	0	2	Unique Assemblies
477	1906	0110	0000	01	11	157101284	G	DDB1	3074U134	275U20		
478	1910	1010	0000	01	11	77244069	G	DZB1	173U21	3		
479	1914	1100	0000	01	11	83069677	G	JGS1	201U3			
480	1918	0000	0111	00	11	56148915	G	DRS1	203U1	25		
481	1922	0000	1011	00	11	30532509	G	MIS1	702U159	210U18	2U1	
482	1926	0001	0011	00	11	79442079	G	JWN1	407U38	53U2		
483	1930	0010	0011	00	11	61134556	G	JWN1	258U12	23U1		
484	1934	0100	0011	00	11	47569448	G	JWN1	364U8	107U1		
485	1938	1000	0011	00	11	27997569	G	MVL1	281U38	255U6		
486	1942	0100	0101	00	11	44412727	G	MVL1	362U36	92U5		
487	1946	0001	1001	00	11	33888861	G	MVL1	68U4	8		
488	1950	0010	1001	00	11	23920751	G	MVL1	78U44			
489	1954	0011	0001	00	11	62051240	N	JWN1	116U1	8		
490	1958	0101	0001	00	11	50061175	N	JWN1	362U10	26		

Ornt - Orientation Number

N - Notchable

User - Who Ran Case

U in Level 8,9

Table 10 - Unique Level-10 Solutions - AF Forma

Original Assembly (LL Format)	Identify	L	H	Lvs	LTyp	Asm	Sol	P	m	M	S	St	Ap	dsaugcC	LL Forma (for sta
05355105440304501111010324226636	387#0108	8	7	A-1	5A00	2	1	0	A	A	1	22	1	0134836	545005304
05355105440304501111010344226636	387#0109	8	7	A-1	5A00	2	1	0	A	A	1	22	1	0134826	545005304
05355105440304501111010364226636	387#0110	8	7	A-1	5A00	2	1	0	A	A	1	22	1	0134826	545005304
05355105440304501111010304226636	387#0111	8	8	A-1	5A00	2	1	0	A	A	1	22	1	0134826	545005304
00045015113504521100613364226466	393#0501	C	7	A-1	59AA	7	1	0	A	A	1	27	2	0024836	545005304
00045015113504521100613364226664	393#0518	C	7	A-1	59AA	3	1	0	A	A	1	27	2	0134836	545005304
00045015113544521100613604226664	393#0634	8	7	A-1	5A00	7	1	0	A	A	1	21	1	0034726	545005304
00005015113544521100613604226664	393#0639	8	8	A-1	4A00	20	1	2	A	A	1	24	1	0024626	545005304
05355105410304501110440324226636	461#0727	C	7	A-1	59AA	2	1	0	A	A	1	29	2	0024935	545005304
55355131140304001130642222000636	462#0366	C	8	A-1	59AA	9	1	0	A	A	1	37	4	0024835	545005304
05355131140304051130642222000636	462#0367	C	8	A-1	59AA	9	1	0	A	A	1	31	2	0024935	545005304
55545131143040501136042222006064	462#1917	C	7	A-1	59AA	6	1	0	A	A	1	29	2	0034935	545005304
55545131143040001136042222006064	462#1933	C	8	A-1	59AA	8	1	0	A	A	1	37	4	0024835	545005304
50545131143040501136042222006064	462#1970	C	8	A-1	59AA	4	1	0	A	A	1	31	2	0134935	545005304
55545130143540001131042222006064	466#1264	8	8	A-1	4A00	7	1	0	A	A	1	25	1	0024725	545005304
05355105440304501101010324226636	475#0184	8	8	A-1	5A00	8	1	0	A	A	1	25	1	0024735	545005304
05355105440304501101010364226636	475#0185	8	8	A-1	4A00	6	1	0	A	A	1	25	1	0024725	545005304
00005015113504521100643324226664	481#0804	C	8	A-1	59AA	20	1	2	A	A	1	29	4	0025835	545005304

Table 11 - High-Level Notchable Solutions - AF Format

LL Format of Rotated Assembly (for standardized apart-code)	L	H	Lvs	LTyp	Asm	Sol	P	m	M	S	St	Ap	dsaugcC	Move1	Move2	Move
-----																
Level-10 Notchable Solutions (all)																
-----																
54541000003224221100143224226060	C	9	A-1	46AA	56	36	0	1	A	1	28	2	2100028	116	21246	121
54541000003024021100143224226060	C	11	A-1	44AA	112	77	0	1	A	1	35	4	2000026	116	21246	121
-----																
Level-9 Notchable Solutions (all)																
-----																
54541131143202221131140002026060	6	7	9-2	9000	26	16	0	1	9	1	14	2	1100028	116	2F3	* 1E2
54540130143202221131140002026060	6	9	9-2	9000	52	32	0	1	9	2	14	2	1000026	116	2F3	* 1E2
54541131143202221031040002026060	6	9	9-2	9000	52	32	0	1	9	2	15	4	1000026	116	2F3	* 1E2
50551131043202221131440002026060	6	9	9-2	9000	416	179	0	1	9	1	12	2	0000026	116	2F3	1E2
50551130043202221133440002026060	6	10	9-1	9000	288	140	6	1	9	1	11	2	0100026	116	2F3	1E2
50551131043202221031440002026060	6	10	9-2	9000	416	179	0	1	9	1	12	2	0000026	116	2F3	1E2
50551031043202221131440002026060	6	10	9-2	9000	416	179	0	1	9	1	12	2	0000026	116	2F3	1E2
50550130043202221133440002026060	6	11	9-1	9000	576	308	6	1	9	3	11	2	0000026	116	2F3	1E2
50551130043202220133440002026060	6	11	9-1	9000	288	154	4	1	9	2	11	2	1000026	116	2F3	1E2
50551130043202221033440002026060	6	11	9-1	9000	576	308	6	1	9	3	11	2	0000026	116	2F3	1E2
50551030043202221133440002026060	6	11	9-1	9000	288	154	4	1	9	2	11	2	1000026	116	2F3	1E2
50550130043202221131440002026060	6	11	9-2	9000	576	308	6	1	9	3	12	2	0000026	116	2F3	1E2
50551130043202221133440002006060	6	11	9-1	9000	288	181	6	1	9	1	13	2	0100025	116	2F3	1E2
50551030043202221133440002006060	6	12	9-1	9000	288	203	4	1	9	1	13	2	1000025	116	2F3	1E2
50551130043202221033440002006060	6	12	9-1	9000	576	399	6	1	9	2	13	2	0000025	116	2F3	1E2
50550130043202221133440002006060	6	12	9-1	9000	576	399	6	1	9	2	13	2	0000025	116	2F3	1E2
-----																
Level-8 Notchable Solutions (all)																
-----																
55551131000554226630040064026606	6	9	8-2	8000	416	179	0	1	9	1	12	2	0000026	112	326	1F2
55551131000204226630040064026606	6	10	8-1	8000	288	140	6	1	9	1	11	2	0100026	112	326	1F2
05551131000554226630040064026606	6	10	8-2	8000	416	179	0	1	9	1	12	2	0000026	112	326	1F2
50551131000554226630040064026606	6	10	8-2	8000	416	179	0	1	9	1	12	2	0000026	112	326	1F2
54540030443202221131140002026060	6	10	8-2	8000	96	92	0	1	8	1	13	2	1000026	116	2F3	* 1E2
55551131000554226630040064020606	6	10	8-2	8000	416	253	0	1	8	1	14	2	0000026	112	326	1F2
55501131000204226630040064026606	6	11	8-1	8000	576	308	6	1	9	3	11	2	0000026	112	326	1F2
55051131000204226630040064026606	6	11	8-1	8000	288	154	4	1	9	2	11	2	1000026	112	326	1F2
05551131000204226630040064026606	6	11	8-1	8000	576	308	6	1	9	3	11	2	0000026	112	326	1F2
50551131000204226630040064026606	6	11	8-1	8000	288	154	4	1	9	2	11	2	1000026	112	326	1F2
55501131000504226630040064026606	6	11	8-2	8000	576	308	6	1	9	3	12	2	0000026	112	326	1F2
50551131000554226630040064020606	6	11	8-2	8000	416	263	0	1	8	1	14	2	0000025	112	326	1F2
55551131000204226630040064020606	6	11	8-1	8000	288	181	6	1	9	1	13	2	0100025	112	326	1F2
55501131000504226630040064020606	6	12	8-2	8000	576	399	6	1	9	2	14	2	0000025	112	326	1F2
50551131000204226630040064020606	6	12	8-1	8000	288	203	4	1	9	1	13	2	1000025	112	326	1F2
55051131000204226630040064020606	6	12	8-1	8000	288	203	4	1	9	1	13	2	1000025	112	326	1F2
55501131000204226630040064020606	6	12	8-1	8000	576	399	6	1	9	2	13	2	0000025	112	326	1F2
55051133442050020036642060226606	C	9	8-1	5888	260	109	0	1	8	1	18	2	0000026	112	* 211	* 3145
35351031443200221131140000026060	C	10	8-1	5888	240	133	0	1	8	1	18	1	1000026	116	2F3	1E2
55051130442050020036642060226606	C	10	8-1	5888	252	143	0	1	8	1	22	2	1000026	112	* 211	* 3145
54541000003324021100143224226060	8	10	8-1	6800	260	167	0	1	8	1	24	2	1000026	116	21246	121
54541000003344551100143224226060	8	9	8-1	6800	171	142	0	1	8	1	20	2	0000026	116	21246	121
54541000003344001100143224226060	8	11	8-1	6800	344	323	0	1	8	1	21	2	1000026	116	21246	121
55050030042052021136042602226060	C	11	8-1	3588	200	178	0	1	8	1	18	4	2010027	1126	325	1F2
05050030042052021136042602226060	C	12	8-1	3588	356	349	0	1	8	1	21	4	2010027	1126	325	1F2
55051133440050020033640660220666	C	10	8-1	8888	352	179	0	1	8	1	16	4	0000026	112	* 211	* 3145
54541135040200220033640660020666	C	10	8-1	8888	260	224	0	1	8	1	17	4	0000026	112	* 211	* 3145
54540030443020221131140000206060	8	12	8-2	3800	408	393	0	1	8	1	20	2	1000025	116	2F3	* 1D2

54540030443200221131140000026060	8	12	8-2	3800	328	320	0	1	8	1	22	4	1000025	116	2F3	*	1D2
55051130440050020033640660220666	C	11	8-1	5688	512	349	0	1	8	1	21	4	1000026	112	*	211	* 3145
550511310000442000330406042226060	C	13	8-2	4888	864	694	0	1	8	2	15	2	1000034	116	313		111
555011310000440200330406042226060	C	13	8-2	3888	864	694	0	1	8	2	21	2	1000034	116	313		111

LL Format of Rotated Assembly  
(for standardized apart-code)

	L	H	Lvs	LTyp	Asm	Sol	P	m	M	S	St	Ap	dsaugcC	Move1	Move2	Move	
-----																	
Level-7 Notchable Solutions (selected solutions only)																	
-----																	
54541135110544226630010064026606	6	7	7-1	7000	38	29	0	1	7	1	12	2	0000026	112	*	326	1F2
55051130142054020033042204223636	6	8	7-1	7000	74	60	0	1	7	1	10	4	0100026	112	*	211	* 325
55051131142054020030042204226666	6	8	7-1	7000	56	22	0	1	7	1	14	4	1200026	112	*	211	* 325
55051131142054020030042204226464	6	8	7-1	7000	60	34	0	1	7	1	12	6	1000026	112	*	211	* 325
55051131042054020030642204223636	6	8	7-1	7000	8	6	0	1	7	1	10	4	1100036	112	*	211	* 325
55051131142054020030042204223636	6	8	7-1	7000	54	36	0	1	7	1	10	4	0100026	112	*	211	* 325
55051130142054020033042204226464	6	8	7-1	7000	69	50	0	1	7	2	12	6	1000026	112	*	211	* 325
55051130142054020033042204226666	6	8	7-1	7000	31	12	0	1	7	1	12	4	2200036	112	*	211	* 325
55051130142054020036042204226464	6	8	7-1	7000	69	50	0	1	7	2	12	6	1000026	112	*	211	* 325
55051131042054020030442044226666	6	8	7-1	7000	156	43	0	1	7	1	12	4	0100026	112	*	211	* 325
55051131042054020030442044226464	6	8	7-1	7000	60	35	0	1	7	1	11	4	1000028	112	*	211	* 325
55051131142054020030042064223636	6	8	7-1	7000	46	23	0	1	7	1	10	4	0100035	112	*	211	* 325
55051131042054020030642064223636	6	8	7-1	7000	24	15	0	1	7	1	10	4	0100035	112	*	211	* 325
55051131042054020030442044223636	6	8	7-1	7000	56	37	0	1	7	1	10	4	0000026	112	*	211	* 325
55051130142054020033042064223636	6	8	7-1	7000	24	19	0	1	7	1	10	4	1100035	112	*	211	* 325
55051131042052020030442062223636	6	8	7-1	7000	32	20	0	1	7	1	10	4	1010037	112	*	211	* 325
50551135140552226630040062026606	6	8	7-1	7000	52	20	0	2	7	1	13	2	1000026	112		326	1F2
35355530543202221131440002026060	6	8	7-1	7000	40	24	0	1	7	1	10	1	0000026	116		2F3	1E2
35355530443202221131440002026060	6	8	7-1	7000	40	26	0	1	7	2	9	1	0000026	116		2F3	1E2
35355530443202221131140002026060	6	8	7-1	7000	40	26	0	1	7	2	9	1	0000026	116		2F3	1E2
50551135110554226630010064026606	6	8	7-1	7000	48	17	0	1	7	1	12	2	1000026	112	*	326	1F2
54541135110504226630010064026606	6	8	7-1	7000	44	41	0	1	7	1	13	4	0000026	112	*	326	1F2
30305535443544551131143224226060	C	4	7-1	7777	7	6	0	2	7	1	15	6	1110026	116		2F35	115
30305535443544551130143224226060	C	5	7-1	7777	34	22	0	1	7	1	16	7	0110026	116		2F35	115
30305535443544551131103224226060	C	5	7-1	7777	7	6	0	2	7	1	15	6	1110026	116		2F35	115
30305535443544551101143224226060	C	5	7-1	7777	7	6	0	2	7	1	15	6	1110026	116		2F35	115
30305535113544551031113224226060	C	5	7-1	7777	22	16	0	2	7	1	11	4	0110026	116		2F35	115
30305535013544551131113224226060	C	5	7-1	7777	22	17	0	2	7	1	12	4	0110026	116		2F35	115
30305505443544551131143224226060	C	5	7-1	7777	7	6	0	2	7	1	15	6	1110026	116		2F35	115
30305535443544551101143324226060	C	5	7-2	7777	16	7	0	1	7	1	12	3	0110026	116		2F35	115
30305535013544551130113224226060	C	6	7-1	7777	34	30	0	1	7	1	21	9	0110026	116		2F35	115
30305535013544551131013224226060	C	6	7-1	7777	59	49	0	1	7	1	12	4	0110026	116		2F35	115
30305505443544551101143324226060	C	6	7-1	7777	36	15	0	1	7	1	12	3	0110026	116		2F35	115
30305535013544551031113224226060	C	6	7-1	7777	22	17	0	2	7	1	12	4	0110026	116		2F35	115
30305505443544551101143224226060	C	6	7-1	7777	11	7	0	1	7	1	17	6	1110026	116		2F35	115
30305535013544551136013224226060	C	6	7-1	7777	36	23	0	1	7	1	18	10	0110036	116		2F35	115
30305535443544551130103224226060	C	6	7-1	7777	34	22	0	1	7	1	16	7	0110026	116		2F35	115
30305505443544551131103224226060	C	6	7-1	7777	7	6	0	2	7	1	15	6	1110026	116		2F35	115
30305535440544551131103224226060	C	6	7-1	7777	7	6	0	2	7	1	15	6	1110026	116		2F35	115
30305535443544551131103024226060	C	6	7-1	7777	34	22	0	1	7	1	16	7	0110026	116		2F35	115
30305535443544551100143224226060	C	6	7-1	7777	34	22	0	1	7	1	16	7	0110026	116		2F35	115
30305535443544551101143220226060	C	6	7-1	7777	7	6	0	2	7	1	15	6	1110026	116		2F35	115
50551135140552220030640062020606	8	10	7-1	4700	176	159	0	1	7	1	23	2	1000026	112		336	1F2
55051131040004200033040604226060	C	13	7-2	3777	768	621	0	1	7	2	18	1	1100034	116		313	111
54541135110544220030610004020666	8	9	7-1	3700	148	125	0	1	7	1	17	2	0000025	112	*	336	1F2
35351031543200221131140000026060	C	10	7-1	5677	240	133	0	1	8	1	14	1	1000026	116		2F3	1E2
30305505443544551101103224226060	C	7	7-1	6777	11	7	0	1	7	1	21	6	1110026	116		2F35	115

05551131143200220130140000026060	C	12	7-1	3577	768	297	0	1	7	1	19	1	2000026	116	2F3	1E2
05551131143200220036040000026060	C	13	7-1	3677	864	674	0	1	7	1	27	1	1000024	116	2F3	1E2
05551130500004001033040604226060	C	14	7-2	477730722664			0	1	7	2	28	6	0000024	116	313	* 111
05051131540050200030040064226606	C	13	7-2	27771224	980		0	1	7	1	26	6	1000024	112	* 211	* 1F5
05551030540004001133000604226060	C	14	7-2	227730722664			0	1	7	2	51	6	0000024	116	313	* 111

Table 12 - Examples - AF Format

LL Format of Rotated Assembly (for standardized apart-code)	6-Piece Burr Puzzle Name	L	H	Lvs	LTyp	Asm	Sol	P	m	M	S	St	Ap	d
50541131042042220633042002226466	Bill's Baffling Burr	6	7	5-1	5000	24	1	0	5	5	1	5	1	0
54551131143202226031140002226060	The Piston Puzzle	6	7	9-3	9000	10	1	0	9	9	1	11	1	1
55550130540004551133440602226060	Love's Dozen	6	9	C-3	C000	154	90	3	1	C	1	18	2	0
54545133402222221133400004226466	Diff. at Length 10 & 12	A	5	5-3	3350	1	1	0	5	5	1	16	2	1
35355533512054221131112644226464	Notchable 1-Hole Level-2	8	1	2-1	2222	4	4	0	1	2	1	2	1	0
50501135442002201133442622226060	L5 Notchable	6	7	5-1	5000	30	1	0	5	5	1	9	4	1
54541000003224221100143224226060	L46AA Notchable	A	9	A-1	46AA	56	36	0	1	A	1	28	2	2
55541131102242226636102242066664	Comp. Choice - 3-Hole	6	3	7-1	7777	7	1	0	7	7	1	9	2	0
54541133400552220633402222626464	Comp. Choice - 4-Hole	6	4	8-3	8000	5	1	0	8	8	1	10	2	0
54551133403220221633403260066466	Comp. Choice - 5-Hole	8	5	9-1	9999	7	1	0	9	9	1	17	4	0
54500530403350551133402022226466	Comp. Choice Unique-10	8	7	A-1	5A00	7	1	0	A	A	1	21	1	0
54541035403520221106403620226464	Partial Level-6 Soln	8	6	6-0	4600	12	0	2	0	0	0	8	1	2
55541131042202220031640064200666	Most ASM - Unique Lev-8	A	8	8-1	2888	111	1	0	8	8	1	16	4	0
05551131143024220130140024226060	Most ASM - Notch Lev-5	A	8	5-1	3555	480	1	0	5	5	1	9	1	1
55551131512054021036012664226466	Bill's Ball-Bearing Burr	8	4	3-1	3333	3	1	0	3	3	1	4	2	0
55550030040004221130040004226060	The 139 Burr	A	14	0-0	2200	16	8	0	1	1	8	139	1	4
55051131440040226136140022606606	Programmer's Nightmare	8	8	0-0	0000	102	0	0	0	0	0	8	1	0



Table 13 - User Contribution Status

HOLEY 6-PIECE BURR ANALYSIS PROJECT  
USER TIME ESTIMATES

August 26, 1990

USER	ASSEMBLIES ANALYZED			
	LOW-HOLE(0-2)	GB6(3-5 HOLES)	HB6(6-15)	HIGH-HOLE
BCP0	820178319.	601961558.	932639605.	203974.
HLN1	0.	5651067887.	9230654948.	0.
MIS1	400000000.	763859281.	449742380.	0.
SBL1	0.	67247523.	6683126.	0.
JWN1	0.	994315396.	900290663.	0.
JGS1	0.	1279126986.	1550393138.	0.
DDB1	0.	1395021419.	1426136538.	0.
GRV1	0.	1608125826.	1086886999.	0.
JBW1	0.	1482772301.	1127322096.	0.
DZB1	0.	0.	514350987.	0.
MVL1	0.	0.	1645888000.	0.
ARS1	0.	0.	130204210.	0.
DRS1	0.	0.	559732376.	0.
JZD1	0.	0.	18535636.	0.
GWP1	0.	0.	476729287.	0.
JJM1	0.	0.	537060776.	0.
TOTALS	1220178319.	13843498177.	20593250765.	203974.

USER	NAME	MACHINE	ASSEMBLIES	AT-HOURS	AT-YEARS
BCP0	BILL CUTLER	PC AT W/386	2354983456.	34654.	3.95595
HLN1	HARRY NELSON	CRAY(S)	14881722835.	223432.	25.50595
MIS1	PAUL GILLES	PS-2 MOD 50	1613601661.	17590.	2.00804
SBL1	STEVE LILLIE	PS-2 MOD 30	73930649.	635.	.07255
JWN1	JIM NOLAN	12MHZ WELL'S	1894606059.	28214.	3.22082
JGS1	JOE SAHIOUNI	COMPAQ 386	2829520124.	47425.	5.41386
DDB1	DAVE BLACK	COMPAQ 386	2821157957.	43851.	5.00581
GRV1	GREG VASSMER	COMPAQ 386	2695012825.	31799.	3.62997
JBW1	JOHN WAGNER	COMPAQ 386	2610094397.	41286.	4.71300
DZB1	DAVID BRUCE	LEADING EDGE	514350987.	10823.	1.23550
MVL1	MATTI LINKOLA	(SEVERAL)	1645888000.	31814.	3.63175
ARS1	ALLAN SLOCUM	8MHZ AT	130204210.	2176.	.24845
DRS1	DAN STRUBEL	COMPAQ 386	559732376.	10759.	1.22824
JZD1	JAMES DALGETY	PC	18535636.	314.	.03580
GWP1	GLENN PEISKER	386	476729287.	12716.	1.45157
JJM1	JERRY MCFARLAND	386	537060776.	10010.	1.14273
TOTALS			35657131235.	547500.	62.50000

Table 14 - Project Status Report

HOLEY 6-PIECE BURR ANALYSIS STATUS AS OF August 26, 1990

--NOTCHABLE--			-----GENERAL-----											
#	TOTAL	MAX	ASSEMBLY	NUMBER	PCT	MAX	-----LEVEL	OF	SOLUTION	-	PERCENT	OF	ANALY	
HOLES	COUNT	LEVEL	COUNT	ANALYZED	DONE	LEV	NOMOVE	MOVE	1	2	3	4	5	
0	588	1	25062952.	25062952.	100.00	1	99.7	.0	.31	.00	.00	.000	.000	
1	5626	2	227537087.	227537087.	100.00	3	99.1	.2	.51	.07	.04	.000	.000	
2	31964	5	967578280.	967578280.	100.00	5	97.4	1.4	.82	.26	.15	.000	.000	
3	119012	5	2562966111.	2562966111.	100.00	7	93.1	4.6	1.30	.67	.37	.002	.001	
4	330559	7	4745611122.	4745611122.	100.00	8	85.3	10.4	2.03	1.47	.75	.015	.005	
5	711998	7	6534920944.	6534920944.	100.00	9	73.5	19.0	3.15	2.86	1.35	.063	.019	
6	1238596	7	6953240417.	6953240417.	100.00	9	58.5	29.2	4.79	5.04	2.24	.201	.061	
7	1773537	9	5864033782.	5864033782.	100.00	10	41.8	38.6	7.17	8.19	3.50	.530	.162	
8	2127755	7	3990281962.	3990281962.	100.00	10	26.2	44.1	10.53	12.32	5.24	1.195	.368	
9	2157545	10	2218794579.	2218794579.	100.00	12	14.0	43.0	15.14	17.25	7.56	2.329	.707	
10	1863092	9	1017259780.	1017259780.	100.00	10	6.1	34.8	21.31	22.42	10.33	3.862	1.118	
11	1372038	10	386810776.	386810776.	100.00	10	2.1	22.1	29.30	26.80	12.87	5.278	1.410	
12	861106	9	122359090.	122359090.	100.00	10	.5	10.1	39.27	28.97	13.88	5.725	1.379	
13	457442	8	32194807.	32194807.	100.00	10	.1	2.8	51.14	27.63	12.37	4.785	1.047	
14	203405	7	7019238.	7019238.	100.00	10	.0	.4	64.34	22.70	8.77	3.106	.645	
15	73992	6	1256334.	1256334.	100.00	8	.0	.0	77.64	15.52	4.78	1.683	.340	
16	21339	5	181583.	181583.	100.00	6	.0	.0	89.15	7.97	1.94	.787	.148	
17	4628	5	20560.	20560.	100.00	5	.0	.0	96.84	2.36	.49	.272	.044	
18	700	1	1730.	1730.	100.00	1	.0	.0	100.00	.00	.00	.000	.000	
19	64	1	96.	96.	100.00	1	.0	.0	100.00	.00	.00	.000	.000	
20	5	1	5.	5.	100.00	1	.0	.0	100.00	.00	.00	.000	.000	

TOTAL ASSEMBLIES = 35657131235.  
 ANALYZED ASSEMBLIES = 35657131235.  
 ANALYZED PERCENT = 100.00

NOTCHABLE ASSEMBLIES = 13354991

CPU TIME ESTIMATES:

TIME USED TO DATE = 62.50000 AT-YEARS  
 TOTAL TIME NEEDED = 62.50000 AT-YEARS

COMPLETION PERCENTAGE =100.00

HIGH LEVEL SOLUTIONS FOUND SO FAR:

LEVEL-8: 60784 LEVEL-9: 6792 LEVEL-10: 373 LEVEL-11: 0 LEVEL-12: 1  
 UNIQUE: 5254 355 18 0 0