

Classification of Mechanical Puzzles and Physical Objects Related to Puzzles

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Background. “Mechanical Puzzles” is the descriptive term used for what are also known as “Chinese Puzzles.” Several attempts have been made to classify mechanical puzzles, but most attempts so far have either been far too specialized in application or too general to provide the basis for a definitive classification. Many people have provided a great deal of help, but particular thanks are due to Stanley Isaacs, David Singmaster, and Jerry Slocum.

Objective. To provide a logical and easy-to-use classification to enable non-experts to find single and related puzzles in a large collection of objects, and patents, books, etc., related to such objects. (As presented here, while examples are given for most groups, some knowledge of the subject is required.)

Definitions. A *puzzle* is a problem having one or more specific objectives, contrived for the principle purpose of exercising one’s ingenuity and/or patience. A *mechanical puzzle* is a physical object comprising one or more parts that fall within the above definition.

Method. A puzzle should be classified by the problem that its designer intended the solver to encounter while attempting to solve it. Consider a three-dimensional (3-D) interlocking assembly in the form of a cage with a ball in the center. The fact that the instructions request the would-be solver to “remove the ball” does not change the 3-D assembly into an opening puzzle. The disassembly and/or reassembly of the cage remains the primary function of the puzzle. An interlocking puzzle should be classified according to its interior construction, rather than its outward appearance (e.g., a wooden cube, sphere, barrel, or teddy bear may all have similar Cartesian internal construction and so should all be classified as Interlocking-Cartesian).

For updated information and illustrations, go to <http://puzzlemuseum.com>.

In cases where it seems possible to place a puzzle in more than one category, it must be classified in whichever is the most significant category. A few puzzles may have to be cross-referenced if it is absolutely necessary; usually, however, one category will be dominant.

A good example of multiple-class puzzles is the “Mazy Ball Game” made in Taiwan in the 1990s. It is based on a 3×3 sliding block puzzle under a clear plastic top. The pieces have L-shaped grooves, and a ball must be rolled up a ramp in the lower right onto one of the blocks – the ball must be moved from block to block, and the blocks themselves must be slid around so that the ball can exit at the top left. Thus the puzzle requires Dexterity, Sequential movement, and Route-finding. It would be classified as Route-finding because, if the route has been found, then the dexterity and sequential movement must also have been achieved.

A puzzle will be referred to as two-dimensional (2-D) if its third dimension is irrelevant (e.g., thickness of paper or plywood or an operation involving a third dimension such as folding). Most standard jigsaws are 2-D, although jigsaws with sloping cuts in fact have a relevant third dimension, so they must be classed as 3-D. It will be noted that the definition of a puzzle excludes the infant’s “posting box,” which, while perhaps puzzling the infant, was contrived only to educate and amuse; it also excludes the archer attempting to get a bull’s-eye, the exercise of whose ingenuity is entirely incidental to the original warlike intent of the sport. Also excluded are puzzles that only require paper and pencil (e.g., crossword puzzles), unless they are on or part of some physical object.

It is understood that specialist collectors will further subdivide the subclasses to suit their own specialized needs. For example, Tanglement-Rigid & Semi-Rigid is awaiting a thorough study of the topology of wire puzzles.

The full abbreviations consist of three characters, hyphen, plus up to four characters, such as “INT-BOX.” These are the standard abbreviations for the classes that have been chosen for relative ease of memory and conformity with most computer databases.

The fourteen main classes are as follows:

- *Dexterity Puzzles (DEX)* require the use of manual or other physical skills in their solution.
- *Route-finding Puzzles (RTF)* require the solver to find either any path or a specific path as defined by certain rules.
- *Tanglement Puzzles (TNG)* have parts that must be linked or unlinked. The linked parts, which may be flexible, have significant freedom of movement in relation to each other, unlike the parts of an interlocking puzzle.

- *Opening Puzzles (OPN)* are puzzles in which the principle object is to open it, close it, undo it, remove something from it, or otherwise get it to work. They usually comprise a single object or associated parts such as a box with its lid, a padlock and its hasp, or a nut and bolt. The mechanism of the puzzle is not usually apparent, nor do they involve general assembly/disassembly of parts that interlock in 3-D.
- *Interlocking Puzzles (INT)* interlock in three dimensions; i.e., one or more pieces hold the rest together, or the pieces are mutually self-sustaining. Many clip-together puzzles are “non-interlocking.”
- *Assembly Puzzles (Non-Interlocking) (ASS)* require the arrangement of separate pieces to make specific shapes without regard to the sequence of that placing. They may clip together but do not interlock in 3-D. Some have a container and are posed as packing problems.
- *Jigsaw Puzzles (JIG)* are made from cut or stamped-out pieces from a single complete object, and the principle objective is to restore them to their unique original form.
- *Pattern Puzzles (PAT)* require the placing or arrangement of separate pieces of a similar nature to complete patterns according to defined rules. The pattern required may be the matching of edges of squares, faces of a cube, etc. The pattern may be color, texture, magnetic poles, shape, etc. Where the pattern is due to differences in shape, the differences must be sufficiently minor so as not to obscure the similarity of the pieces.
- *Sequential Movement Puzzles (SEQ)* can be solved only by moves that can be seen to be dependent on previously made moves.
- *Folding and Hinged Puzzles (FOL)* have parts that are joined together and usually do not come apart. They are solved by hinging, flexing, or folding.
- *Jugs and Vessels (JUG)*. Vessels having a mechanical puzzle or trick in their construction that affects the filling, pouring, or drinking therefrom.
- *Other Types of Mechanical Puzzles and Objects (OTH)*. This group is for puzzle objects that do not easily fall into the above categories and cannot be categorized into sufficiently large groups to warrant their own major class. Included in this group are Balancing, Measuring, Cutting, Math, Logic, Trick, Mystery, and Theoretical Puzzles. Also, provision is made for puzzles pending classification.
- *Ambiguous Pictures and Puzzling Objects (AMB)*. Puzzles in which something appears impossible or ambiguous.

- *Ephemera (EPH)*. This category has been included because most puzzle collections include related ephemera, which, while not strictly puzzles, need to be classified as part of the collection.

A detailed classification with second-level classes is given in the separate table. Puzzle Class Abbreviations (PZCODE) are standardized to a maximum of eight characters: XXX-YYYY, where XXX is the main class and YYYY is the sub-class. Examples of puzzles in each class are given in the right-hand column.

Proposed Developments

Prior to 1998 the subclasses attempted to incorporate the number of dimensions, the type of structure, and any group/non-group moves. This has resulted in an unwieldy list. We are now working on defining what should be included automatically in the subclasses where they are relevant. We hope to reduce the number of sub-classes substantially in the near future.

Number of Dimensions. 2-D, 3-D, 2-D on 3-D, 2-D to 3-D, 2-D, 3-D, and 4-D. Required for INT JIG ASS PAT RTF SEQ FOL.

Group Moves. Whether needed, not needed, or partly used in solution. Required for SEQ.

Number of Pieces. Required for INT JIG ASS PAT.

Type of Piece Structure. Required for INT ASS PAT.

Examples of approved structure adjectives that may be used include

- *Identical*: All pieces identical
- *Cartesian*: Three mutually perpendicular axes
- *Diagonal*: Pieces rotated 45 degrees along their axis
- *Skewed*: Like a squashed puzzle
- *Polyhedral*
- *Geometrical*: Non-Cartesian but geometrical structures
- *Organic*: Amorphously shaped pieces
- *Ball*: Pieces made from joined spheres
- *Rod*: Square, hexagonal, triangular, etc.
- *Linked*: Pieces joined together by hinges, strings, ribbons, etc.

Thus a standard six-piece burr uses square rods in a Cartesian structure, and the standard Stellated Rhombic Dodecahedron has a six-piece Diagonal Cartesian structure.

Guide to Making a Catalogue or Database for Puzzle Collections

Headings for cataloguing puzzle collections could include the following items. In practice, without paid curators, it is probably advisable to be selective and limit the amount of information recorded.

Generalized Information

- Generic name of puzzle or objective if not obvious. **required
- Class + Subclass **required

Information Specific to This Object

- Theme or advertisement (subject)
- Materials
- Dimensions A, B, C; d = diameter. **A required for scale
- What the dimension refers to, i.e., box, envelope, biggest piece, assembled puzzle
- If powered, i.e., battery, clockwork, electric, solar
- Patent and markings
- Notes, references, designer
- Manufacturer or publisher's name and country
- Type of manufacturing, i.e., mass produced (over 5000 pieces made), craft made (commercial but small volume), homemade or tribal
- Year of manufacture **required
- Country of manufacture if different from publisher's country
- Manufacturer's series name
- Manufacturer's product name
- Number in complete set, if known
- Number of set in collection
- A picture or photograph

Information Specific to This Collection

- Location/cabinet/bin
- Acquisition
- Number
- Condition (Excellent, Good, Fair, Poor)
- Condition qualifying note, i.e., puzzle may have a cracked glass top or be missing one piece, but otherwise be in excellent condition.
- Source
- Date
- Cost
- Insurance value

Detailed Puzzle Classification

Class	Description	Example
DEX-	Dexterity Puzzles	
DEX-UNCA	Dexterity or other physical skills in their solution	Cup and Ball, "Le Pendu," "Theo der Turnier," Tomy's "Crazy Maze," puzzles using tops
DEX-BALL	Dexterity; plain balls into holes	Pentangle "Roly-Poly" puzzles
DEX-SDRY	Dexterity with sundry objects and/or obstacles	Ramps, bridges, jumping beans, etc.
DEX-LQOB	Liquid objects	Mercury manipulation
DEX-INLQ	Dexterity in liquid	Water-filled puzzles
DEX-MIRR	Indirect viewing	View by mirror
DEX-MECH	Mechanized	Tomy's "Pocketeers"
DEX-TOOL	Using tools and magnetic tools	
DEX-RTFL	Route following dexterity	
DEX-HIDD	Objects concealed from view	Four Generations "Ball in Block," Engel's "Black Box"
DEX-ELEC	Electrical and electronic dexterities	
DEX-PINB	Pinball-related dexterities	Bagatelle
DEX-OTHR	Other dexterities, pneumatic operation	
RTF-	Route-Finding Puzzles	
RTF-CHNG	Route-finding with changing path and/or Complex Traveller	"Frying Pan," "Yankee," "Tandem Maze" (complex), "Bootlegger" (complex)
RTF-STEP	Route-finding step mazes	Ring and hole mazes, "Pike's Peak"
RTF-UNIC	Unicursal route-finding	Icosian Game, Königsburg Bridges
RTF-SHOR	Shortest route	
RTF-CPLX	Complex route mazes with special objectives	"Worried Woodworm," colour mazes, number totalling mazes, avoiding objects, visiting places en route.
RTF-2D	Route mazes 2-D (any path)	Most hedge mazes

RTF-2D3D	Route mazes 2-D on 3-D surfaces (any path)	Maze on surface of cube
RTF-3D	Route mazes 3-D (any path)	Some hedge mazes, ball in 4 × 4 cube of cubelets
TNG-	Tanglement Puzzles	
TNG-RIGI	Tanglement of rigid and semi-rigid parts	Wire puzzles, cast “ABC,” Chinese rings, puzzle rings
TNG-R&F	Tanglement of rigid and flexible parts	Hess wire puzzles, Dalgety’s “Devil’s Halo”
TNG-FLEX	All flexible	Leather tanglement puzzles
OPN-	Opening Puzzles	
OPN-BOX	Opening containers	Boxes, purses
OPN-LOCK	Opening locks	Padlocks
OPN-HID	Opening/finding hidden compartments not originally designed as puzzles	Chippendale tea chests, poison rings
OPN-OTHR	Opening other objects	Nuts and bolts, knives, pens, cutlery, Oskar’s keys, Oscar’s “Dovetail,” “Hazelgrove Box”
INT-	Interlocking Puzzles	
INT-BOX	Boxes that disassemble	Strijbos aluminium burr box
INT-CART	Cartesian (has parts along three mutually perpendicular axes)	Burrs, “Mayer’s Cube,” “Margot Cube,” Cutler’s burr in a glass
INT-POLY	Interlocking polyhedral	Coffin’s “Saturn”
INT-SHAP	Other rigid shapes	JWIP and keychain animals, berrocals, “Tak-it-Apart,” “Nine of Swords,” keychain cars
INT-TENS	Tensegrity structures in which compression and tension elements separate	“Plato’s Plight”
ASS-	Assembly Puzzles	
ASS-MAT	Match stick puzzles and tricks	
ASS-2D	2-D Assembly	Tangram, Pentominoes, gears, checkerboards, “T” puzzle
ASS-CART	3-D Cartesian Assemblies	Polycubes, Soma, “Hoffman” cube, O’Beirne’s “Melting Block”

ASS-POLY	3-D Assembly Polyhedra and Spheres	Ball pyramids, Squashed Soma, nine-piece ivory cube
ASS-SHAP	3D Assembly Other Shapes	Pack the Plums, Apple and Worms, "Managon," "Even Steven," "Phoney Baloney," Gamnt's "Chandy"
JIG-	Jigsaw Puzzles	
JIG-STD	Standard jigsaws	Can include double-sided puzzles
JIG-3D	3-D jigsaws	
JIG-2DID	2-D jigsaws with identical pieces for secondary objectives	"Shmuzzles" tessellations
JIG-PART	2-D jigsaws which only partially cover the plane	Billhourd's jigsaws
JIG-SLOP	2-D jigsaws with non-perpendicular/sloping cuts	
JIG-LAYR	Multiple-layer 2-D jigsaws	"Sculpture Puzzles"
JIG-2D3D	2-D jigsaws with parts that can be made into 3-D objects	"Toyznet"
JIG-BLOX	Picture cubes/blocks	
PAT-	Pattern Puzzles	
PAT-2DPG	Pattern arrangements of points, pegs, or pieces, according to predetermined rules	Queens on chess board, BlackBox, Josephus, Waddington's "Black Box"
PAT-STIX	Patterns of sticks	Match puzzles, Jensen's "Tricky Laberint"
PAT-NUM	Pattern: arrangements of number	Magic squares, number puzzles
PAT-2DEG	2-D matching edge patterns	Heads and tails
PAT-2D	Arrangement of 2-D pieces on 2-D surface to make a pattern according to predetermined rules	"Testa"
PAT-STAK	Stacking, overlapping, and weaving 2-D patterns	Stacking transparent layers, "Lapin," Loyd's Donkeys, weaving puzzles
PAT-2D3D	Patterns with 2-D parts on 3-D surface	"Dodeca"

PAT-3D	3-D pattern puzzles with separate parts	“Instant Insanity,” Waddington’s “Kolor Kraze,” Skor Mor “Instant Indecision,” Chinese balls in ball, Oscar’s “Solar System,” Laker Cube
PAT-LINK	Linked part pattern puzzles	Bognar’s planets, Panel Nine, “Dodecahedru” – rotating faces of Dodecahedron
SEQ-	Sequential Puzzles	
SEQ-PLAC	Sequential placement	Psychic Pz, Fit Pz
SEQ-RIVR	Sequential river crossing	“Wolf, Sheep and Cabbage”
SEQ-HOPP	Sequential hopping and jumping	Solitaire, Tower of Hanoi, counter and peg moving puzzles
SEQ-SL2D	Sequential sliding and shunting in 2-D	15s Pz., Tit-Bit’s “Teasers”
SEQ-SL3D	Sliding and shunting in 3-D (only single piece moves needed)	“Inversions”
SEQ-SLRO	Sliding and shunting with mechanical or rotating parts (single piece moves and group moves needed)	“Tower of Babel,” “Missing Link,” “Backspin,” “Turntable Train”, Tomy’s “Great Gears”
SEQ-RT2D	Sequential rotating in 2-D (group moves only)	Raba’s “Rotascope,” Rubik’s “Clock”
SEQ-RT3D	Sequential rotating and/or mechanical in 3-D (group moves only)	Rubik’s Cube, “Masterball,” “Jugo Flower,” “Orbit,” “Kaos”
SEQ-ROLL	Sequential rolling	Rolling eight cubes
SEQ-MMEC	Sequential miscellaneous mechanical	“The Brain,” “Hexadecimal,” “Spin Out”
FOL-	Folding Puzzles	
FOL-SING	Folding single-part puzzles	“Why Knots,” Möbius strips
FOL-HGOP	Folding hinged parts in open loop	Rubik’s “Snake,” strung cubes
FOL-HGCL	Hinged parts in closed loop	Flexagons, Rubik’s “Magic,” “Flexicube”
FOL-HSEP	Folding hinged parts that separate	“Clinch Cube”

FOL-SH2D	Folding sheets and strips into 2-D solution	Map folding, "Jail Nixon"
FOL-SH3D	Folding sheets and strips into 3-D shapes	Strip polyhedra
JUG-	Puzzle Jugs	
JUG-STD	Puzzle mugs standard	Standard "block holes and suck" solution
JUG-CPLX	Complex mugs requiring special manipulation	
JUG-BASE	Pour from base	"Jolly Jugs"
JUG-NLID	Lidless wine jugs	Cadogan teapots, Chinese winepots
JUG-OTHR	Self-pouring and other patents	Royale's patent
OTH-	Other Types of Puzzle	
OTH-ELEC	Electrical and electronic (non-dexterous)	Luminations
OTH-BAL	Balancing (non-dexterity)	"Columbus Egg"
OTH-MEAS	Measuring and weighing puzzles	Jugs and liquids, 12 Golf Balls, Archimedes gold
OTH-CUT	Cutting puzzles	Cork for three holes, five square puzzle
OTH-RIDD	Riddles	19th century riddle prints
OTH-WORD	Word puzzles	Anagrams, rebus plates and prints, crosswords on bathroom tissue
OTH-MATH	Mathematical puzzles (excluding number pattern arrangements)	
OTH-LOGI	Logic puzzles	Cartoon pictures to arrange in order
OTH-TRIK	Trick or catch puzzles (solution needs subterfuge)	"Infernal Bottle"
OTH-MAGI	Conjuring tricks presented as puzzles	Disappearing coin slide box
OTH-MYST	Objects whose function or material is a mystery	Creteco spacers
OTH-SET	Sets of puzzles of mixed type	
OTH-THEO	Puzzles whose existence is only theoretically possible...	such as 4-D puzzles, or those that can only be represented on a computer

OTH-PEND	Pending Classification !!!	Puzzles awaiting classification
AMB-	Ambiguous	
AMB-POBJ	Paradoxical objects (objects that apparently cannot be made)	Arrow through bottle, impossible dovetails, Oskar's "Escher Puzzle," Penrose triangle
AMB-VANI	Vanishing images	"Vanishing Leprechauns," Hooper's paradox
AMB-DIST	Distortions	Anamorphic pictures
AMB-ARCH	Archimboldesque objects	Pictures and objects of one subject made from completely unrelated objects
AMB-HIDD	Hidden image pictures (no manipulation required)	Devinettes (obscure outlines), "Spot the Difference," random dot stereograms
AMB-HMAN	Hidden image pictures (manipulation required)	"Naughty Butterflies," "Find the 5th Pig" needing coloured overlays, soot on unglazed part of ashtray
AMB-TURN	Pictures that require turning to show different images	Landscape turned to make a portrait, Topsey Turveys, OHOs, courtship/matrimony
AMB-ILLU	Perception illusions	Optical illusions, weight illusions
EPH-	Ephemera related to puzzles	
EPH-WIWO	Wiggle Woggle HTL	Hold to light cards producing movements by shadows
EPH-MICR	Micro Printing	Images concealed by extreme smallness
EPH-MOIR	Moiré effect	Puzzles/effects produced by moiré/fringe effects
EPH-HTL	Hold to light	Protean views, hold to light advertisements
EPH-HEIR	Heiroglyphs (non-rebus)	Obscure non-rebus heiroglyphic prints
EPH-ANAG	Anaglyphs	Requiring red and green glasses for either 3-D or movement effects
EPH-STRP	Strip prints (three views in one frame)	Framed strip prints showing different views from different directions

EPH-OTHR	Other puzzle-related ephemera	
XXX-XXX	Lost records	For database integrity only
DEL	Deleted record	Puzzle disposed of; no longer in collection