

RPG Maker XP documentation

David Rodriguez Soares

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1 What this document is about

This document holds information about how RPG Maker XP implements *Maps* and *Events*, which is relevant in project PoGER's map/feature extraction effort.

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As a result of the limited scope of PoGER and the limited time and information available to the author, the following documentation isn't complete and may not be accurate.

The information was obtained through the official RPG Maker XP built-in documentation, user content found on the internet (forum posts, videos) and the author's reverse-engineering work.

The following abbreviations may be present :

- **RMXP** - RPG Maker XP
- **PE** - Pokemon Essentials

Please note that the author is not a native English speaker.

1.1 Related documents

This is but one in a collection of manuscripts, each with its scope (*sorted older to newer*) :

- **Vision document** : A very early analysis about Pokemon Essentials, focused on identifying its issues and properties of a hypothetical software solution.
- **PoGER** : Gives information on the project itself, including motivations and objectives.
- **RMXP doc** : Contains the results of my research about RPG Maker XP's implementation of game data (mostly *Maps* and *Events*), with the objective to extract them to an interpretable format.
- **Extraction** : Contain a practical guide on the extraction process for anyone trying to reproduce it.

2 How RMXP stores data

A crucial first step in any reverse-engineering effort in data extraction is to understand used data structures.

As RMXP games run on a *Ruby interpreter*, every element we encounter is either of a *primitive type* or an *object* (class instance).

Ruby primitive types :

- Arrays
- Hashes
- Boolean
- Symbols
- Numbers
- Strings

For the task at end, let's focus on the classes that are associated with maps and events, most of which are part of the RMXP library (other are defined in PE scripts). See *RMXP_full.png*

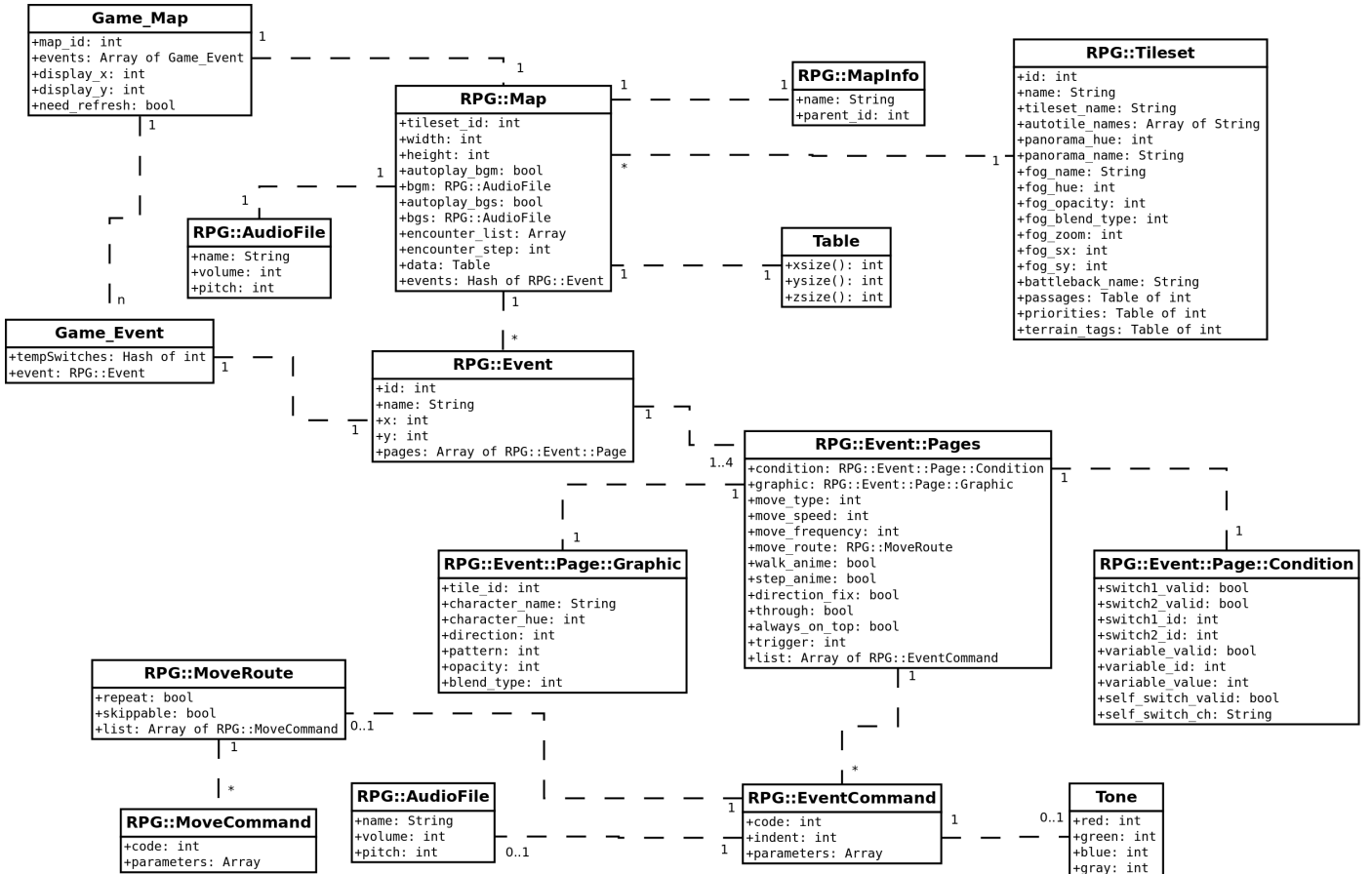


Figure 1: Simplified class map representation for Map/Event

Semantic/Syntax : Linked classes (with arity) display an **associative relationship**.

Note : There is no inheritance relationship between any two classes represented. Arities are logically deduced and may not be exact depending in proprietary implementation details. Class `RPG::AudioFile` was duplicated for ease of association routing.

3 Events

An event, or more precisely a *map event*, is a way to introduce elements with behavior, therefore bringing flexibility and dynamism into the game world.

Events have two aspects :

- A GUI element

Edit Event - ID:004

Name:

1 2

Conditions


☐ Switch is ON

☐ Switch is ON

☐ Variable is or above

☐ Self Switch is ON

Graphic:



Autonomous Movement

Type:

Speed:

Freq:

Options

☒ Move Animation

☐ Stop Animation

☐ Direction Fix

☐ Through

☐ Always on Top

Trigger

☐ Action Button

☐ Player Touch

☒ Event Touch

☐ Autorun

☐ Parallel Process

List of Event Commands:

```
@>Comment: Battle: \bHi! I like shorts! They're comfy and easy to wear!
@>Comment: Type: YOUNGSTER
@>Comment: Name: Ben
@>Comment: EndSpeech: Aww, I lost.
@>Comment: EndBattle: \bYou can't get a trainer event simpler than me!
@>Script: pbTrainerIntro(:YOUNGSTER)
@>Script: Kernel.pbNoticePlayer(get_character(0))
@>Text: \bHi! I like shorts! They're comfy and easy to wear!
@>Conditional Branch: Script: pbTrainerBattle(:YOUNGSTER,"Ben",_I("Aww, I lost."))
@>Control Self Switch: A =ON
@>Branch End
@>Script: pbTrainerEnd
@>
```

- Its data class instance counterpart `RPG::Event`

```

Map031_events > {} Map031_eventTrainer(2)_json > {} pages > {} 0
1 {
2   "class": "Event",
3   "name": "Trainer(2)",
4   "x": 5,
5   "y": 14,
6   "pages": [
7     {
8       "class": "Page",
9       "condition": {
10        "class": "Page::Condition",
11        "switch1": null,
12        "switch2": null,
13        "self_switch": null,
14        "variable": null,
15        "variable_value": null
16      },
17      "graphic": {
18        "class": "Page::Graphic",
19        "tile_id": 0,
20        "character_name": "trchar037",
21        "character_hue": 0,
22        "direction": "Down",
23        "pattern": 0,
24        "opacity": 255,
25        "blend_type": "Normal"
26      },
27      "move": "Fixed",
28      "move_speed": 3,
29      "move_frequency": 3,
30      "walk_anime": true,
31      "step_anime": false,
32      "direction_fix": false,
33      "through": false,
34      "always_on_top": false,
35      "trigger": "onEventTouch",
36      "list": [
37        {
38          "class": "EventCommand",
39          "code": 108,
40          "indent": 0,
41          "parameters": "Battle: \\bHi! I like shorts! They're
42        },
43        {
44          "class": "EventCommand",
45          "code": 408,
46          "indent": 0,
47          "parameters": "wear!"
48      ],
49    },
50    {
51      "class": "EventCommand",
52      "code": 108,
53      "indent": 0,
54      "parameters": "Type: YOUNGSTER"
55    },
56    {
57      "class": "EventCommand",
58      "code": 108,
59      "indent": 0,
60      "parameters": "Name: Ben"
61    },
62    {
63      "class": "EventCommand",
64      "code": 108,
65      "indent": 0,
66      "parameters": "EndSpeech: Aww, I lost."
67    },
68    {
69      "class": "EventCommand",
70      "code": 108,
71      "indent": 0,
72      "parameters": "EndBattle: \\bYou can't get a trainer e
73    },
74    {
75      "class": "EventCommand",
76      "code": 408,
77      "indent": 0,
78      "parameters": "than me!"
79    },
80    {
81      "class": "EventCommand",
82      "code": 355,
83      "indent": 0,
84      "parameters": "pbTrainerIntro(:YOUNGSTER)"
85    },
86    {
87      "class": "EventCommand",
88      "code": 355,
89      "indent": 0,
90      "parameters": "Kernel.pbNoticePlayer(get_character(0))
91    },
92    {
93      "class": "EventCommand",
94      "code": 101,
95      "indent": 0,
96      "parameters": "\\bHi! I like shorts! They're comfy a

```

3.1 Basic functionalities

These are the easiest and most straightforward behavior to implement into an event :

- Giving an element a *sprite* (texture) : This is useful for objects capable of movement, NPCs, etc.
- *Movement* : Select how the element moves with presets (speed, frequency, pattern, etc).
- *Event commands* : Select the trigger for behavior and what the element does when triggered (movement, dialogue, etc) within the extensive command list.

3.2 Advanced functionalities

These require an understanding of conditional execution and scripting :

- *Conditional execution* : branching instructions based on the value of : global variables, global switches, self switches, script return, etc.
- *Pages* : Allow to give an element different behavior depending on conditions.
- *Move routes* : Define a sequence of movement commands to be executed.
- *Script calls* : Call a script to be executed for more complex behavior, launching mini-games, retrieving data, etc.

4 Commands

Commands are a mechanism, through which most of an `RPG::Event`'s behavior is defined.

Although they are very similar in structure and use, a distinction is made between `RPG::EventCommand` and `RPG::MoveCommand`.

EventCommands are the representation of elements present in the "List of Event Commands" in the GUI. They are the building block of event's behavior.

MoveCommands are the representation of an individual movement the event is capable of, typically found in sequences `RPG::MoveRoute` associated with a dedicated *EventCommand*.

They both have, at least :

- A *code* : An integer that uniquely identifies the particular command.
- *Parameters* : Depend on the particular command, can be empty, a variable, an object, or a list of objects.

Additionally, *EventCommands* have an *indent* integer value, tied to the layout visible in the "List of Event Commands" in the GUI.

4.1 Methodology

In order to successfully *extract semantic from events*, it was decided that *documenting* every command used in Pokemon Essentials and finding an appropriate (human-readable) *representation* was the way forward.

The objective is to formalize a **DSL** (Domain Specific Language) into which events will be translated to, which exhibit desirable properties ([See Command Representation decisions section](#)).

4.2 Miscellaneous information

Codes used in Pokemon Essentials 17.2 (*81 total*) :

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 33, 34, 37, 38, 39, 40, 41, 42, 44, 101, 102, 104, 106, 108, 111, 112, 113, 115, 118, 119, 121, 122, 123, 125, 201, 202, 208, 209, 210, 221, 222, 223, 225, 231, 232, 235, 236, 241, 242, 247, 248, 249, 250, 314, 354, 355, 401, 402, 404, 408, 411, 412, 413, 655

Implementation details :

- `RPG::MoveCommand` use range [1-45]
- `RPG::EventCommand` use range [101- x], $x \geq 655$
- A "frame" is defined as $\frac{1}{20}$ second \Rightarrow change into milliseconds $m = n * 1000 / 20 \equiv n * 50$.
- Every event has an ID (integer > 0). Actions that can affect other events can target the player using id -1 and the current event using id 0.
- Special variables : MapID, PartyMembers, Gold, Steps, PlayTime, *Timer*, SaveCount.

They should all be read accessible. Underlined ones should also be write accessible. *Italic ones are probably not used*.

4.3 List of commands

0	Description Parameters Notes	Nothing, empty command or end of the event command list None Will not be represented
1	Description Parameters Notes	<code>RPG::MoveCommand</code> - Move to the South None See footnote ¹
2	Description Parameters Notes	<code>RPG::MoveCommand</code> - Move to the West None See footnote ¹
3	Description Parameters Notes	<code>RPG::MoveCommand</code> - Move to the East None See footnote ¹
4	Description Parameters Notes	<code>RPG::MoveCommand</code> - Move to the North None See footnote ¹
5	Description Parameters Notes	<code>RPG::MoveCommand</code> - Move to the SouthWest None See footnote ¹
6	Description Parameters Notes	<code>RPG::MoveCommand</code> - Move to the SouthEast None See footnote ¹
7	Description Parameters Notes	<code>RPG::MoveCommand</code> - Move to the NorthWest None See footnote ¹
8	Description Parameters Notes	<code>RPG::MoveCommand</code> - Move to the NorthEast None See footnote ¹
9	Description Parameters Notes Representation	<code>RPG::MoveCommand</code> - Move at random (N,E,S,W) None See footnote ¹ "Move, R"
10	Description Parameters Notes	<code>RPG::MoveCommand</code> - Move towards player None See footnotes ^{1,3}
11	Description Parameters Notes	<code>RPG::MoveCommand</code> - Move away from player None See footnotes ^{1,3}
12	Description Parameters Notes	<code>RPG::MoveCommand</code> - Take 1 step forward None See footnote ¹

13	Description	RPG::MoveCommand - Take 1 step backward
	Parameters	None
	Notes	See footnote ¹
14	Description	RPG::MoveCommand - Jump to relative coordinates on the same map
	Parameters	[2] - 0:deltaX [signed integer], 1:deltaY [signed integer]
	Notes	
15	Description	RPG::MoveCommand - Wait n seconds
	Parameters	[1] - 0:number of seconds to wait n [integer $\in \mathbb{N}^*$]
	Notes	Typically $n == 2$, but values up to 15 were found in PE.
16	Description	RPG::MoveCommand - Turn towards South
	Parameters	None
	Notes	See footnote ²
17	Description	RPG::MoveCommand - Turn towards West
	Parameters	None
	Notes	See footnote ²
18	Description	RPG::MoveCommand - Turn towards East
	Parameters	None
	Notes	See footnote ²
19	Description	RPG::MoveCommand - Turn towards North
	Parameters	None
	Notes	See footnote ²
20	Description	RPG::MoveCommand - Turn 90° right, relative to current position
	Parameters	None
	Notes	See footnote ²
21	Description	RPG::MoveCommand - Turn 90° left, relative to current position
	Parameters	None
	Notes	See footnote ²
22	Description	RPG::MoveCommand - Turn 180°
	Parameters	None
	Notes	See footnote ²
23	Description	RPG::MoveCommand - Turn 90° to the left or right, at random
	Parameters	None
	Notes	See footnote ²
24	Description	RPG::MoveCommand - Turn at random (90° or 180°)
	Parameters	None
	Notes	See footnote ²
25	Description	RPG::MoveCommand - Turn towards player
	Parameters	None
	Notes	See footnotes ^{2,3}
26	Description	RPG::MoveCommand - Turn away from player
	Parameters	None
	Notes	See footnotes ^{2,3}

33	Description Parameters Notes	RPG::MoveCommand - Turn ON walking animation None
34	Description Parameters Notes	RPG::MoveCommand - Turn OFF walking animation None
37	Description Parameters Notes	RPG::MoveCommand - Turn ON "through" None Equivalent to activating "walk through walls", making it possible to walk through impassable tiles/characters.
38	Description Parameters Notes	RPG::MoveCommand - Turn OFF "through" None Equivalent to deactivating "walk through walls".
39	Description Parameters Notes	RPG::MoveCommand - Always on top ON None Elevate the display priority, therefore bringing the event graphic to the forefront (above any tile/character)
40	Description Parameters Notes	RPG::MoveCommand - Always on top OFF None
41	Description Parameters Notes	RPG::MoveCommand - Change event's graphic [2] - 0:texture file [String], 1:hue, 2:direction d [integer], 3:step [integer 0-3] See note ⁵ . 0 without extension. 1 is unused.
42	Description Parameters Notes	RPG::MoveCommand - Change event's graphic opacity [1] - 0:new opacity value n [integer 0-255]
44	Description Parameters Notes	RPG::MoveCommand - Play a sound effect TODO
101	Description Parameters Notes	RPG::EventCommand - Show text [1] - 0:text s [String] s must be properly double-quoted and formatted (inner double-quotes and backslashes must be escaped).
401	Description Parameters Notes	RPG::EventCommand - Show text (continued) [1] - 0:text s [String] Continuation of 101.
102	Description Parameters Notes	RPG::EventCommand - Show choices [2] - 0:array of size n [Array of Strings], 1:cancel behaviour [integer 0-4] Displays up to 4 selectable options in a message window. Cancel behaviour : 0 disallow canceling, $1-4 \leq n$ selects choice by default.
104	Description Parameters Notes	RPG::EventCommand - Change text options [2] - 0:position p [integer 0-2], 1:window border b [integer 0-1] Sets message window position and border. p follows "common relation 1", b follows "common relation 2"
106	Description Parameters Notes	RPG::EventCommand - Wait [1] - 0:number of frames to wait n [integer $\in \mathbb{N}^*$] Conversion to milliseconds chosen for its more precise and general use : $m = n * 1000/20 \equiv n * 50$, TODO:research its use

108	Description	RPG::EventCommand - Comment
	Parameters	[1] - 0:comment text <i>s</i> [String]
	Notes	Has no effect. TODO:research link to particle effects.
408	Description	RPG::EventCommand - Comment (continued)
	Parameters	[1] - 0:comment text <i>s</i> [String]
	Notes	Happens after a 108.
111	Description	RPG::EventCommand - Conditional branch
	Parameters	See " Conditional branch " section.
	Notes	Complex but essential command.
112	Description	RPG::EventCommand - Loop
	Parameters	None
	Notes	Loops over commands until broken. TODO:research usage
113	Description	RPG::EventCommand - Break loop
	Parameters	None
	Notes	Escape innermost loop. TODO:research usage
115	Description	RPG::EventCommand - Exit Event Processing
	Parameters	None
	Notes	TODO:research usage
118	Description	RPG::EventCommand - Label
	Parameters	[1] - 0:label name <i>s</i> [String]
	Notes	Sets a label to allow jumping to.
119	Description	RPG::EventCommand - Jump to Label
	Parameters	[1] - 0:label name <i>s</i> [String]
	Notes	Jumps to a label.
121	Description	RPG::EventCommand - Control switches
	Parameters	[3] - 0:starting switch <i>ssa</i> [integer], 0:ending switch <i>ssz</i> [integer], 0:state <i>n</i> [integer]
	Notes	Batch control is unused in PE, therefore deprecated. <i>n</i> follows "common relation 3".
122	Description	RPG::EventCommand - Control variables
	Parameters	See " Control variables " section.
	Notes	Batch control is unused in PE, therefore deprecated.
123	Description	RPG::EventCommand - Control Self Switch
	Parameters	[2] - 0:SS character <i>s</i> [String of length 1], 1:new state <i>n</i> [integer 0-1]
	Notes	<i>n</i> follows "common relation 3".
125	Description	RPG::EventCommand - Change Gold
	Parameters	[3] - 0:operation <i>o</i> [integer 0-1], 1:operand <i>n</i> [integer 0-1], 2:value <i>v</i> [integer]
	Notes	Values of <i>n</i> : 0: <i>v</i> is a constant, 1: <i>v</i> is a variable(id). <i>o</i> follows "common relation 4"
201	Description	RPG::EventCommand - Transfer Player
	Parameters	[6] - 1:map <i>m</i> [integer], 2:coordinate <i>x</i> [integer], 3:coordinate <i>y</i> [integer], 4:player direction <i>d</i> [integer], 5:fading <i>f</i> [integer].
	Notes	{0} must be 0, 1 unused in PE. <i>d</i> follows "common relation 5". <i>f</i> follows "common relation 3".

202	Description Parameters Notes	<code>RPG::EventCommand</code> - Set Event Location [5] - 0:event id <i>e</i> [integer], 2:coordinate <i>x</i> [integer], 3:coordinate <i>y</i> [integer], 4:direction <i>d</i> [integer] Change an event's location on the current map. {1} must be 0, other values unused in PE. <i>d</i> follows "common relation 5".
208	Description Parameters Notes	<code>RPG::EventCommand</code> - Change Transparency Flag [2] - 0:flag <i>d</i> [integer 0-1] When transparency is set, the graphic isn't displayed. <i>d</i> follows "common relation 3".
209	Description Parameters Notes	<code>RPG::EventCommand</code> - Set Move Route [2] - 0:target id <i>d</i> [integer], 1: <code>RPG::MoveRoute</code>
210	Description Parameters Notes	<code>RPG::EventCommand</code> - Wait for Move's Completion None To be put after a Set Move Route. Without it, further commands can be executed before the end of the walking animation.
221	Description Parameters Notes	<code>RPG::EventCommand</code> - Prepare for transition None Freezes the screen, so there's nothing moving during the transition. To be fused with <code>Execute Transition</code> .
222	Description Parameters Notes	<code>RPG::EventCommand</code> - Execute Transition [1] - 0:transition file name <i>s</i> [String] Plays the animation. TODO:research how transition work.
223	Description Parameters Notes	<code>RPG::EventCommand</code> - Change Screen Color Tone [2] - 0: <code>RPG::Tone</code> , 1:duration(frames) <i>d</i> [integer] Typically used in fade out (to black/white)/fade in cycles. <i>d</i> to be changed into ms.
225	Description Parameters Notes	<code>RPG::EventCommand</code> - Screen Shake [3] - 0:shake power [integer], 1:shake speed [integer], 2:duration(frames) <i>d</i> [integer] Scarcely used in PE, {0} and {1} are not well defined so they can be deprecated. <i>d</i> to be changed into ms.
231	Description Parameters Notes	<code>RPG::EventCommand</code> - Show Picture See " Show Picture " section.
232	Description Parameters Notes	<code>RPG::EventCommand</code> - Move Picture See " Move Picture " section.
235	Description Parameters Notes	<code>RPG::EventCommand</code> - Erase Picture [1] - 0:picture id [integer]
236	Description Parameters Notes	<code>RPG::EventCommand</code> - Set Weather effect [3] - 0:weather id [integer], 1:power [integer], 2:transition duration (frames) [integer] <i>power</i> and <i>transition duration</i> to be removed. TODO:research how weather is generated. <i>weather id</i> follows "common relation 13".
241	Description Parameters Notes	<code>RPG::EventCommand</code> - Play BGM [1] - 0:audio <i>a</i> [AudioFile]
242	Description Parameters	<code>RPG::EventCommand</code> - Fade Out BGM [1] - 0:duration (seconds) <i>n</i> [integer]

247	Description Parameters Notes	<code>RPG::EventCommand</code> - Memorize BGM/BGS None
248	Description Parameters Notes	<code>RPG::EventCommand</code> - Restore BGM/BGS None
249	Description Parameters Notes	<code>RPG::EventCommand</code> - Play ME [1] - <code>0:audio a [AudioFile]</code>
250	Description Parameters Notes	<code>RPG::EventCommand</code> - Play SE [1] - <code>0:audio a [AudioFile]</code>
314	Description Parameters Notes	<code>RPG::EventCommand</code> - Restore All [1] - <code>0:actor id [integer]</code> Equivalent to healing and restoring PPs. Ignore parameter.
354	Description Parameters Notes	<code>RPG::EventCommand</code> - Return to Title Screen None
355	Description Parameters Notes	<code>RPG::EventCommand</code> - Script [1] - <code>0:script string [String]</code> To be overhauled.
655	Description Parameters Notes	<code>RPG::EventCommand</code> - Script (continued) [1] - <code>0:script string [String]</code> To be overhauled.
402	Description Parameters Notes	<code>RPG::EventCommand</code> - When [1] - <code>0:choice id [integer]</code> , <code>1:choice string equivalent [integer]</code> Used with choices and conditional branches, has code block per choice.
404	Description Parameters Notes	<code>RPG::EventCommand</code> - End of When None
411	Description Parameters Notes	<code>RPG::EventCommand</code> - Else None Used with conditional branch 111.
412	Description Parameters Notes	<code>RPG::EventCommand</code> - Branch End None End of a code block (as result of branching). TODO:investigate whether it is present in every code block and if it should be represented (is indentation sufficient?).
411	Description Parameters Notes	<code>RPG::EventCommand</code> - Repeat above None Marks end of Loop 112 code block.

¹Movements consolidated with new *Move* command with argument.

²Turs consolidated with new *Turn* command with argument.

³Unknown algorithm to determine direction "towards player" and "away from player."

⁴Is part of a command sequence that should be merged in a sensible way.

⁵*step* is the horizontal offset (column), *direction* is the vertical offset.

4.3.1 Common relations

In parenthesis are the proposed representation or information :

1. 0:Top, 1:Middle, 2:Bottom
2. 0:Show, 1:Hide
3. 0:ON, 1:OFF
4. 0:Increase, 1:Decrease (+, -)
5. 0:Keep same, 2:Down, 4:Left, 6:Right, 8:Up (K,S,W,E,N)
6. 0:'==', 1:'>=', 2:'<=', 3:'>', 4:'<', 5:'!='
7. 0:constant, 1:variable
8. 0:'>=', 1:'<='
9. 0:'=', 1:'+=', 2:'-=', 3:'*=', 4:'/', 5:'%' (affectation, increment, decrement, multiplication, division, modulo)
10. 0:coordinate X, 1:coordinate Y, 2:direction (3-5 unused)
11. 0:NW, 1:Centered (picture coordinate origin)
12. 0:Normal, 1:Additive, 2:Subtractive (blending type)
13. 0:None, 1:Rain, 2:Storm, 3:Snow

TODO:determine if division is always rounded to an integer (and how) or not.

4.4 Complex commands

Some commands have complex behaviour that doesn't fit in the table above, therefore detailed explanation were put here instead.

4.4.1 Conditional branch - 111

This command is RMXP's equivalent of an 'if' instruction, and therefore hinges on expressing a condition. Given the expansive list of conditions that can be expressed, its syntax is quite complex.

The *first parameter* is crucial : it defines the type of condition. **integer** 0-12 :

- 0 Check *Switch* state.

Parameters	[3] - 1:switch id <i>n</i> [integer], 2:switch state <i>d</i> [integer 0-1]
Notes	<i>d</i> follows "common relation 3".
Representation	"If, <i>n.toString()</i> , <i>d.toString()</i> "

- 1 Check *Variable* value.

Parameters	[5] - 1:variable id <i>n</i> [integer], 2:what it is compared to <i>m</i> [integer] 3:constant or variable id <i>x</i> [integer], 4:comparator <i>c</i> [integer]
Notes	<i>c</i> follows "common relation 6", <i>m</i> follows "common relation 7".
Representation	<i>m</i> =='constant' : "If, <i>n.toString()</i> , <i>c.toString()</i> , <i>x</i> " <i>m</i> =='variable' : "If, <i>n.toString()</i> , <i>c.toString()</i> , <i>x.toString()</i> "

2 Check *Self-Switch* state.

Parameters	[3] - 1 :self switch character n [String of size 1], 2 :switch state d [integer 0-1]
Notes	d follows "common relation 3".
Representation	"If, n , $d.toString()$ "

6 Check *Event* direction.

Parameters	[3] - 1 :event id n [integer], 2 :direction d [integer 0-1]
Notes	d follows "common relation 5".
Representation	"If, $n.toString()$, Facing, $d.toString()$ "

7 Check *Player's money*.

Parameters	[3] - 1 :amount n [integer], 2 :comparator d [integer 0-1]
Notes	d follows "common relation 8".
Representation	"If, Money, $d.toString()$, n "

12 Check *Script's return*.

Parameters	[2] - 1 :Script s [String]
Notes	Script must return a boolean (prehaps returning nothing is OK?)
Representation	"If, Script, s "

Values 3,4,5,8,9,10,11 were not found in PE, therefore not researched.

4.4.2 Control variables - 122

Parameters **0** and **1** [integer] are indexes for the range of variables that will be affected. Variable is s

As batch control of variables is unused in PE, it is deprecated in the representation (parameter **1** is ignored).

Parameter **2** o [integer 0-5] sets the **operation** to be performed on the variable, and follows "common relation 9".

Parameter **3** defines the **operand type** [integer 0-7] :

0 - Constant.

Parameters	[5] - 4 :constant n [integer]
Notes	
Representation	"Control, $s.toString()$, $o.toString()$, n "

2 - Random integer.

Parameters	[6] - 4 :constant a [integer], 5 :constant z [integer]
Notes	Will choose a number $x \in [a, z]$. TODO:check if a and z are included.
Representation	"Control, $s.toString()$, $o.toString()$, $[a, z]$ "

6 - Event's attribute.

Parameters	[6] - 4 :event id n [integer], 5 :attribute id d [integer 0-2]
Notes	d follows "common relation 10".
Representation	"Control, $s.toString()$, $o.toString()$, Event, $n.toString()$, $d.toString()$ "

7 - Only used once, to put the "Money"/"Gold" special variable in a temporary variable to be used in a condition, therefore isn't really needed.

Values 1,3,4,5 were not found in PE, therefore not researched.

4.4.3 Show Picture - 231

This command is only used in the intro.

Description	Display a picture.
Parameters	[10] - 0:picture priority number p [integer], 1:picture name s [String], 2:coordinate origin c [integer 0-1], 3:unused, 4:relative position x [integer], 5:relative position y [integer], 6:horizontal zoom zx [integer], 7:vertical zoom yz [integer] 8:opacity o [integer 0-255], 9:blending type b [integer 0-2]
Notes	c follows "common relation 11", b follows "common relation 12".
Representation	"Show Picture, s , priority= p , coordinates=($c.toString()$, x , y), zoom=(zx , yz), opacity= o , blending= $b.toString()$ "

Picture priority number p is used when multiple pictures are on display, because overlapping textures need to have an unambiguous drawing order.

Here, let there be pictures p_1, p_2 with priorities 2,4 respectively. Therefore, p_1 is drawn first, then p_2 . The result is that, if they are overlapping, p_2 will be drawn **over** p_1 , removing parts of p_1 from being displayed.

Typically, $x = y = 0$

4.4.4 Move Picture - 232

Parameters are mostly identical to "Show Picture". This is mostly used to animate intro's pictures (movement and opacity).

Description	Move a picture.
Parameters	[10] - 0:picture priority number p [integer], 1:duration in frames f [integer], 2:coordinate origin c [integer 0-1], 3:unused, 4:relative position x [integer], 5:relative position y [integer], 6:horizontal zoom zx [integer], 7:vertical zoom yz [integer] 8:opacity o [integer 0-255], 9:blending type b [integer 0-2]
Notes	c follows "common relation 11", b follows "common relation 12".
Representation	"Move Picture, priority= p , coordinates=($c.toString()$, x , y), zoom=(zx , yz), opacity= o , blending= $b.toString()$ "

5 Command Representation

The representation chosen is a result of careful consideration of its future usage requirements (including but not limited to) :

- Readability : It is destined to be read and written by humans, therefore it should be as straightforward and non-cryptic as possible.
- Brevity : In the interest of anyone (human or software) reading/writing it, the *less is more* approach is to be applied : instructions should not be longer than what is necessary.
- Unambiguity : As any formal language, its use and syntax should be unambiguous.
- Simplicity : Limiting the amount of available instructions by combining related ones is good practice.
- Expandability : There should be room left for additional behavior to be implemented.

At the time of writing these lines, representations in this document are still not final, it's a work-in-progress.

Particular decisions

- Python syntax style : Reduces explicit syntax (like semicolons and curly braces), therefore reducing syntax errors. Takes advantage of "implicit" syntax by making indentation itself meaningful.
- Case insensitive : Simplification allowing any program to simply make everything lowercase when reading an *Event*, and users to Use any casing style they prefer. This also makes it harder to have variable/switch name collisions by forcing users to explicitly name their variables.
- Switches, self-switches and variables : Should be all represented as **symbols**.

Proposed representation : `":s"` [**String**] (*string beginning with colon*)

Let **s** be the string representation (name) of the Switch/Self-switch/Variable. **s** of length 1 is to be reserved to self-switches.

Note that merging variables and switches may allow greater flexibility for users.

Ideas

- Timers could be implemented as integers : Let `:PlayTime` be a read-only integer variable that counts the seconds of play time (an *epoch* of sorts).

Then, setting a timer for x seconds could be as simple as storing $(:PlayTime + x)$ in a variable and testing it later against the current value of `:PlayTime` !

- Commands have parameters (see examples) :
 - No parameter : command line must contain the command keyword only.
 - 1 parameter : command line must contain the command keyword, plus the expected parameter `parameter_name = parameter_value` (parameter name recommended but not mandatory; parameter may be facultative)
 - $n > 1$ parameters : command line must contain the command keyword, and the expected parameters `parameter_name = parameter_value` as a comma-separated list (no brackets; parameter name mandatory; parameter may be facultative).
 - Note on *facultative* parameters : marked with a `*`.
 - Strictly equivalent : `' :ON' ≡ 'True'`, `' :OFF' ≡ 'False'`, `'is' ≡ '=='` (when placed where a comparator would be).

5.1 Commands

Description	Step - Move the event (perform 1 step).
Parameters	[1] - 0: direction - [String]
Notes	direction $\in \{S,W,E,N,SW,NW,NE,SE,R,1F,1B,1A,1T\}$, see "Directions" below.
Examples	"Step NW", "Step 1T"
Description	Turn - Turn the event (change direction).
Parameters	[1] - 0: direction - [String]
Notes	direction , see "Directions" below.
Examples	"Turn N", "Turn W"
Description	Move Event - Move Event to absolute/relative coordinates on the same map.
Parameters	[3] - 0:event* - [String/int] (name/id of the event to move) 1:relative_coordinates/absolute_coordinates - [list of 2 int] 2:direction* - [int]
Notes	event is optional, defaults to self. direction is optional, defaults to "K".
Examples	"Move Event relative_coordinates=[7,-5]", "Move Event event=Jack, absolute_coordinates=[4,12]"
Description	Wait - Pause event behavior execution for a given amount of time.
Parameters	[1] - 0: ms/s - [int] (time in milliseconds/seconds)
Notes	If parameter name is unspecified, defaults to s.
Examples	"Wait ms=3000", "Wait s=3"
Description	Set - Set event properties value
Parameters	[2] - 0: property - [String], 1: value - [int/String/:ON/OFF]
Notes	property must be a configuration variable, see "Configuration variables" below. value must be a valid value for that property.
Examples	"Set property=move_animation value=:ON" "Set property=Animation value=:OFF" "Set property=graphic value="trchar28,S,0"
Description	Play - Play audio.
Parameters	[3] - 0: SE/BGM/ME - [String], 1: volume* - [int], 2: pitch* - [int]
Notes	volume and pitch default to 100, their values are relative to 100 (percentage).
Example	"Play BGM="022-Field05", volume=100, pitch=100"
Description	Show Text
Parameters	[1] - 0: text - [String]
Example	"Show Text "Hello, World !"
Description	Choose - Give player a list of items to choose from.
Parameters	[2] - 0: choices - [list of String], 1: default* - [int] <i>n</i> (behavior on cancel)
Notes	If default not set, the player must choose (no cancel). Otherwise, select n^{th} item on the list.
Examples	"Choose choices=["Yes","No"]", "Choose choices=["One","Two","Three"], default=1"
Description	Change Text Options
Parameters	[2] - 0: position* - [Top/Middle/Bottom], 1: border* - [Show/Hide] (window border))
Example	"Change Text Options position=Middle, border=Show"

Description	End Execution - Ends behavior execution.
Parameters	[0]
Example	"End Execution"
Description	Label - Marks a line as a target for a Goto .
Parameters	[1] - 0: name - [String]
Notes	Please find a good name for the label (not like the example).
Example	"Label "here"
Description	Goto - Change line to be executed next.
Parameters	[1] - 0: label - [String]
Example	"Goto "here"
Description	Transfer Player - Teleport player.
Parameters	[6] - 0: map* - [String], 1: x - [int], 2: y - [int] 3: direction* - [String], 4: fading* - [:ON:OFF]
Notes	map defaults to the one the player is in. direction $\in \{S,W,E,N,K\}$, defaults to "K". fading defaults to (TODO).
Example	"Transfer Player map="Kurt's house", x=2, y=4"
Description	Set Move Route - Set a sequence of commands, to be executed by a set event
Parameters	[1] - 0: event* - [String]
Notes	event defaults to self. Must be followed by a <i>code block</i> . Used to move other events or to semantically indicate a "move sequence/route".
Example	See "Move Route" section below.
Description	Screen Shake
Parameters	[1] - 0: duration - [int]
Notes	duration is expressed in milliseconds.
Example	"Screen Shake 600"
Description	Transition - Execute transition visual effect.
Parameters	[2] - 0: name - [String], 1: freeze - [True/False]
Notes	If freeze is enabled, stops every animation.
Example	"Transition name="battle1", freeze=True"
Description	Show Picture
Parameters	TODO
Notes	TODO.
Example	TODO
Description	Move Picture
Parameters	TODO
Notes	TODO.
Example	TODO
Description	Erase Picture
Parameters	TODO
Notes	TODO.
Example	TODO

Description	Set weather - Set overworld's weather.
Parameters	[2] - 0: name - [String], 1: duration* - [int]
Notes	duration defaults to infinite duration. The effect scope of Set weather is to be determined (for current map, radius on the current map, across maps). Provisionally, it's limited to current map.
Example	"Set weather name="Rainy", duration=12000"
Description	Fade out BGM
Parameters	[1] - 0: duration - [int]
Notes	duration in milliseconds.
Example	"Fade out BGM 3000"
Description	Memorize BGx
Parameters	[0]
Example	"Memorize BGx"
Description	Restore BGx
Parameters	[0]
Example	"Restore BGx"
Description	Restore All
Parameters	[0]
Notes	Restore all stats for player's party.
Example	"Restore All"
Description	Return to title screen
Parameters	[0]
Notes	Quits current game and returns to title screen (without saving).
Example	Return to title screen
Description	Save
Parameters	[1] - 0: allow_cancel - [True/False]
Notes	Prompts a "save your progress" dialog to the player.
Example	Save allow_cancel=True

Directions :

- S,W,E,N : South, West, East, North (vertical/horizontal movement)
- Step directions :
 - SW,NW,NE,SE : South-West, North-West, North-East, South-East (diagonal movement, not recommended)
 - R : random movement (S,W,E,N)
 - 1F,1B : one step Forwards/Backwards (according to current orientation/direction)
 - 1A,1T : one step Away from/Towards the player
- Turn directions:
 - "90 Right", "90 Left" : Turn 90 degrees right/left.
 - "random", "90 random" : Turn at random, turn "90 Right" or "90 Left" at random.
 - "towards player", "away from player" : Turn based on player's position.
- Transfer directions:
 - K : Keep the same (for teleportation)

Execution flow control :

- `if code_block [else code_block]?` : For implementing conditional execution of code blocks.
- `loop code_block` : `code_block` must contain a `break` statement for the loop to not be infinite. Infinite loop detection should be implemented.
- `choice ... [when (value) code_block]+` : For implementing behavior on player's choice.

Total :

- 25 (+ 1^{new}) commands + 3 forms of flow control !
- vs. 81 commands !
- 3 pages de doc vs. 9 pages de doc

5.2 Formal grammar

```
EVENT
  : LF* '[event]' LF+ (CONFIG LF)+ LF+ PAGE+ <EOF>

PAGE
  : '[page]' LF+ (CONFIG_OR_COND LF)* LF+ STATEMENTS '[end]' LF+

CONFIG_OR_COND
  : CONFIG_VAR '=' PARAMETER_VALUE
  | LOG_EXPR

STATEMENTS          // block of lines that define an event's behavior
  : (STATEMENT LF+)*

STATEMENT           // line that define an event's behavior
  : 'if' LOG_EXPR LF CODE_BLOCK ('else' LF CODE_BLOCK)?
  | 'loop' LF CODE_BLOCK
  | 'when' WHITESPACE VALUE LF CODE_BLOCK
  | 'break'
  | CMD
  | VAR_MANIPULATION
  | SCRIPT

CODE_BLOCK          // block of lines whose execution is subject to flow control
  : INDENT STATEMENTS DEDENT

CMD
  : CMD_ID PARAMETERS?

PARAMETERS
  : PARAMETER (',' WHITESPACE? PARAMETER)*

PARAMETER
  : (PARAMETER_NAME '=')? PARAMETER_VALUE

PARAMETER_VALUE
  : LIST
  | VALUE
  | BOOL

VAR_MANIPULATION
  : SYMBOL ASSIGN_OPERATOR EXPRESSION

EXPRESSION          // expression that returns a value
  : LOG_EXPR
  | (MATH_OP | NUMBER | SYMBOL)+ // Imperfect : allows invalid expressions
  | SCRIPT
  | PARAMETER_VALUE

LOG_EXPR            // expression that returns a logical value
  : COMPARABLE LOG_OPERATOR COMPARABLE
  | SCRIPT

NUM_EXPR            // expression that returns a numerical value
  : TERM (ADD_OP TERM)*

PARAMETER_NAME
  : WORD
```

```

LIST
    : '[' VALUE (WHITESPACE VALUE)* ']'

SCRIPT
    : s\.*

TERM
    : FACTOR (MUL_OP FACTOR)*

FACTOR
    : NUMBER
    | '(' NUM_EXPR ')'

CMD_ID
    : WORDS

SYMBOL
    : ':' WORD

VALUE
    : NUMBER
    | STRING
    | WORD
    | TURN_VALUE

STRING
    : '"' ['^']* '"'

NUMBER
    : -?[0-9]+('.' [0-9]+)?

LF
    : '\r\n' | '\n'

WORDS
    : WORD+

WORD
    : [a-z][a-z\_0-9]*

BOOL
    : ':ON' | ':OFF' | 'True' | 'False'

LOG_OPERATOR
    : '==' | '>=' | '<=' | '>' | '<' | '!=',

ASSIGN_OPERATOR
    : '=' | '+=' | '-=' | '*=' | '/='

MATH_OP
    : '+' | '-' | '*' | '/'

COMMENT                // Rejected by the lexer
    : #.*

SPACE                  // Rejected by the lexer
    : [ \t]+

```

- CMD_ID is expected to be one of the defined operation. An error should be thrown otherwise.
- Comments must be stripped before lexing. Multi-line comments aren't supported.

- Tokens (terminal values) **INDENT** and **DEDENT** should be generated when reading the event file in order to represent indentation, thus allowing for block of statements to be syntactically represented.

5.2.1 Configuration variables

Mostly contained in the event, but can be overridden by the pages.

CONFIG_VAR	type	Default	Description.
name	String	N/A	Identifies the event.
xy	[int, int]	N/A*	Position of the event.
graphic	String/int	None	Texture of the event.
pattern	int	0	Column index for the sub-texture from graphic to use.
opacity	int	255	0-255 Opacity for event's texture.
transparent	bool	False	Transparency flag. When enabled, graphic isn't displayed.
direction	String	S	[N,E,S,W] Initial facing direction (if has graphic).
trigger	String	"onPlayerAction"	Trigger for the behavior of the event.
move_animation	bool	True	Whether the graphic should be animated when moving/walking.
stop_animation	bool	False	Whether the graphic should be animated when not moving/walking.
direction_fix	bool	False	The direction (of the texture) of the event cannot be changed when True.
through	bool	False	"Walk through walls" switch: when True, collision is ignored and the event can go anywhere (walk on water, walls, holes, etc).
always_on_top	bool	False	Event's graphic should be drawn last, as to always be "on top" of everything else. Scarcely used.
movement	String	"Fixed"	"Fixed", "Random" or "Approach".
movement_speed	String	"Slow"	"Slow" or "Fast". Vaguely defined. Player's movement is "Fast".
preset	String	None	Proposed "preset" for simple, common events (boulder, door, etc).

* : Mandatory configuration, therefore no default.

Notes :

- **graphic** can be either a string (name of a character file) or a int (tile id from the current tileset). Defaults to None : the event has no texture.
- **move_animation:False**, **stop_animation:True** is mostly used for berry trees.
- As anything in an event file, it should be read in a case-insensitive way.
- **trigger** can have values :
 - *onPlayerAction* : The event is triggered by the player interacting (using action button) with it.
 - *onPlayerTouch* : The event is triggered by the player touching (walking into) it.
 - *onTouch* : The event is triggered by the player touching (walking into) it OR the event touching the player.
 - *onAutorun* : The event is triggered when the map is loaded.
 - *ready* : The event is always triggered, its execution is controlled through its behavior conditions.
 - *onSeen n* : The event is triggered when the player is on the event's line of sight, within n tiles (n is optional, defaults to no limit)

5.3 Notes

Unfortunately, it is not possible to cover every command used in PE, just as it is not possible to extract the underlying semantic behind every event, for the simple reason that PE doesn't always implement things in a straightforward way.

Reading some events, it appears obvious that the authors of PE had to work around limitations of event commands, relying on scripts to expand capabilities. These result in artifacts.

These include, but are not limited to :

- Recurring events : Some events, like *doors*, are common and have straightforward behavior, so authors just copy-pasted them everywhere they were needed, only applying modifications when necessary (eg: appearance and transfer destination on doors).

These were the motivation behind the creation of the **preset** configuration variable on events. It would allow for all recurring commands to be abstracted away, allowing for shorter and cleaner events.

- Text hack : According to PE's wiki, there are plenty of modifiers that can be integrated to text in order to modify its behavior : changing text font, size, setting it bold, italic, changing its position or alignment, displaying a selection menu, etc..

This would need to be re-implemented entirely to replicate behavior.

- Arbitrary code : The ability to execute scripts in events, and the global nature of most elements in the game, allows scripts to perform basically any action.

Replicating this much flexibility without a Ruby interpreter and PE's original scripts would be completely impractical. The only sensible way forward would be to implement the basic function calls and elevate the abstraction level for complex behavior, or fixing it by hand. Decision are to be made on a case-by-case basis.

- Arbitrary variable use : This is not exactly an artifact or RMXF's limitations, but one of PE's authors. They sometimes use variables, whose name imply a certain usage scope, for unrelated purposes .

This could have been simply avoided by creating new variables. It is not technically an issue : the game already runs with these artifacts, therefore it doesn't need fixing.

There is no other solution than fixing it by hand (by creating new variables and changing usage).

6 Maps

Here we will focus on `RPG::Map`. Here are its components :

<code>tileset_id</code>	int	Value of a <code>RPG::Tileset</code> unique identifier component <code>id</code> . The <code>RPG::Tileset</code> object can be retrieved through the global hash <code>\$data_tilesets</code> using the <code>id</code> as the key.
<code>width,height</code>	int,int	Attribute equivalent to <code>data.xsize()</code> and <code>data.ysize()</code> .
<code>autoplay_bgx</code>	bool	Indicated whether an audio is to be played as soon as the map is loaded.
<code>bgm/bgs</code>	AudioFile	The audio that is to be played when loading the map. <i>bgs unused by PE</i>
<code>encounter_list</code>	Array	<i>Unused by PE.</i>
<code>encounter_step</code>	int	<i>Unused by PE.</i>
<code>data</code>	Table of int	Contain the <i>map</i> representation of the 3 tile layers.
<code>events</code>	Hash	Contain the <i>Event</i> representation (<code>RPG::Event</code>) for this map.

6.1 Associated classes

- The role of the associated `Game_Map` instance is to be studied further, but current understanding indicated that it is an alias derived from its `RPG::Map` instance that is tailored for PE's needs.
- About the associated `RPG::MapInfo` instance : It contains a few useful informations :

<code>name</code>	String	The name of the map.
<code>parent_id</code>	int	In the map tree, the id of the parent map.

This information can be retrieved directly from the compiled *MapInfos* file :

```
mapinfos = pbLoadRxData("Data/MapInfos")
map_name = mapinfos[id].name
parent_map_id = mapinfos[id].parent_id
parent_map_name = mapinfos[parent_map_id].name rescue nil
```

RMXP allows maps to be structured in a hierarchy, where a map can have a "parent map", but this is only used in the UI to emulate a file system-like tree. This is purely cosmetic. Only the `name` value will be used.

- `RPG::Tileset` : Represents a normal tileset :

<code>id</code>	int	The id of the tileset.
<code>name</code>	String	Its name (no extension).
<code>tileset_name</code>	String	Name of tileset. <i>Moved to Map.</i>
<code>autotile_names</code>	Array of String	Names of associated autotiles (up to 7). <i>Moved to Map.</i>
<code>panorama_*</code>		<i>Unused by PE.</i>
<code>fog_*</code>		<i>Unused by PE.</i>
<code>battleback_name</code>	String	Name of the texture that appears during combat. <i>Moved to Map.</i>
<code>passages</code>	2D Table of int	Properties of individual textures.
<code>priorities</code>	2D Table of int	Properties of individual textures.
<code>terrain_tags</code>	2D Table of int	Properties of individual textures.

- `RPG::AudioFile` : Basic data container :

name	String	The name of the audio file (no extension).
volume	int	Acts like a volume slider, normalized at 100.
pitch	int	Allows to adjust sound pitch, normalized at 100.

A global variable (`$data_tilesets`, `Array`) stores this information.

- **Table** : Used for 2D/3D arrays, with 3 class methods to retrieve dimensions. x and y correspond to their GUI map representation and z the map layers (background, intermediate, foreground).

6.1.1 Values for tileset tables

Each table contains `int` values, one for each texture. This value is to be interpreted .

passages: let's consider the 6 least significant bits

- bit 0 : Cannot move S
- bit 1 : Cannot move W
- bit 2 : Cannot move E
- bit 3 : Cannot move N
- bit 4 : Is a bush
- bit 5 : Is a counter (tile through which interaction is possible)

terrain_tags: see `PBTerrain` module for values.

priorities: default value is 0. Any higher value means that the texture has priority. In practice, it means that the texture is "above" its own layer (drawn last). Combined with passability, it's possible for it to be on the same layer as NPCs/the player and give the illusion that they can pass behind it.

Proposition : integrate **priorities** to **passages** as a 7th bit (*bit 6 : Can be passed behind*).

6.2 About graphical assets

When dealing with (most) graphical assets in RPG Maker XP, including tilesets, autotiles and maps, a few constraints apply.

- The base unit is the **tile**, which is a 32 by 32 square.
- Tilesets must have a horizontal dimension of exactly 8 tiles (256 pixels), but can be arbitrarily tall (n tiles tall).
- Tilesets can have up to 7 associated autotiles. This has proven to be a limiting factor in PE.
- Autotiles are special assets. They can be put on a map like any texture from a tileset, but have the properties of being context-aware and animation-capable :

They form coherent surfaces by manipulating components of their texture in order to give the impression of continuity when multiple instances of the same autotile are neighbors. They can be used to create basically any surface that needs to deal with how its border with an other surface looks.

I identified two formats (*frames are situated side-by-side horizontally*) :

- $3N \times 4$: a 3 tile horizontal, 4 tile vertical, N frame image. This is the official autotile format for RMXP.
- $N \times 1$: a 1 tile horizontal, 1 tile vertical, N frame image. This is used for animated tiles.

- Every tile has properties (see section "values for tileset tables"). This includes autotiles, which notably have a single `passages`, `terrain_tag` and `priorities` value.
- During my map reconstruction attempts, I found out that most maps only use a fraction of tiles available to them and programmed a way of converting maps and their tilesets to a "compact" format (creating an alternate tileset with only used tiles, and adapting map data accordingly).

Although it is functional and may be advantageous for running on low memory systems, the scattering of graphical assets and the loss of tile adjacency render this approach pointless or impractical.

I believe the decision of tying tiles and autotiles together in their object representation, and then using the original tileset file name to refer to said object in maps, was a poor design choice. In consequence, the extraction script decouples maps, autotiles and tilesets, allowing for more flexibility (for example, it raises the possibility of removing the 7 autotile per tileset limit).

6.3 Autotile format

Researching how autotiles are adaptively generated proved to be a tedious manual process of reverse-engineering.

I used the "test map" that was created as a starting point for studying Pokémon Essentials. By placing autotiles in various shapes and extracting map data, I was able to manually correlate tile content to their index (and understand both the absolute and relative indexing systems).

It turns out that autotiles tiles are divided into four separate "sub-tiles" of 16 by 16 pixels, and each index correspond to a combination of sub-tiles into a unique tile.

A2	B4			A1	B1
D8	C10			D1	C1
A2	B2	A3	B3	A4	B4
D2	C2	D3	C3	D4	C4
A5	B5	A6	B6	A7	B7
D5	C5	D6	C6	D7	C7
A8	B8	A9	B9	A10	B10
D8	C8	D9	C9	D10	C10

Figure 2: 3 by 4, single frame autotile format

As you can see, only 10 tiles are actually used out of 12. Some autotile assets contained texture for the redundant/unused tiles for some unidentified reason, which make me suspect there might be something I'm missing about autotiles.

The result of my research can be found in the `AutotilesSubtileMap.ods` spreadsheet file. It lists indexes and their corresponding subtile components. I also implemented a Python program (`LoadImage.py`) that reconstructs maps from map data, tileset and autotiles, including GIF output (see `Map032_out.gif` for example), demonstrating the feasibility of lossless map extraction and reconstruction.

Note : I found [this article](#) helpful for understanding how autotiles work.

6.4 Map representation

At its core, a RPG Make XP map is a *tiled map* : it is a 2-dimensional grid of textures (tiles) of fixed size.

The **data** component is a 3-dimensional table of integer values with the following properties :

- The 3rd dimension is used to represent **layers** : exactly 3 tiled maps are used for any RMXF map :
 - Background : Contains mainly the textures that make the ground and other elements that are always "below player's level". Any event or texture of higher layer will be displayed *above* it.
 - Intermediate : Contains mainly the textures that should be "at player's level", which includes most elements the player can interact with (including bumping into).
 - Foreground : Contains mainly the textures that should be "above player's level", typically used for elements below which the player can stand.
- Each layer obeys the same indexing convention :

Value(s)	Description
0	Reserved value for "No texture"
1-47	Reserved, unused.
48-95	Range used for autotile 1.
96-143	Range used for autotile 2.
⋮	⋮
336-383	Range used for autotile 7.
384-	Range used for tileset.

This way of reserving 48 indexes per autotile results from autotile's mechanism for generating context-aware textures.

Note : each range describes the *absolute positions* between which a *relative indexing system* takes place. For example, index 52 is interpreted as index 4 for autotile 1 and index 485 is index 100 on the tileset (remember that indexes begin at zero, not one).

6.5 Map and Tileset files

There should be a well-defined way of representing extracted map and tileset information.

Map

- Located in the "Maps" directory.
- Naming convention : `<id>_<name>.json` . The *name* is only here as a quality-of-life addition, for developers to easily know what map they're dealing with. It must be present, though.

Extension isn't really important and can always be changed in the future.

- Location agnostic : A map file can be at the root of the "Maps" directory, or in any subdirectory, allowing for the same flexibility as RMXP's UI.
- Content : utf-8 encoded JSON with the following entries

_class	String	Must be "Map".
name	String	Map's name. Used for displaying current location.
width	int	Map's width. Should be checked against the content of table .
height	int	Map's height. Should be checked against the content of table .
battleback	String	Picture to be displayed behind battles.
tileset	String	Map's tileset (file name without extension).
autotiles	Array of String	Map's autotiles (file name without extension).
autoplay_bgm	bool	Sets whether the bmg should be played when entering the map.
bgm	String	Map's background music.
table	3D array of int	Describes map's texture placement (3 layers).

Note : bgm formats : "<name>" or "<name>,<volume>,<pitch>"

Note : **table** must have dimensions **width** x **height** x 3

Tileset and Autotiles

- Located in the "Tileset_data\Tilesets" and "Tileset_data\Autotiles" directories respectively.
- Naming convention : `<name>.json` . The *name* is only here as a quality-of-life addition, for developers to easily know what map they're dealing with. It must be present, though.
- Content : JSON with the following entries

_class	String	Must be "Tileset".
name	String	Tileset's file name (no extension). Referenced by map's property tileset
passages	(1D array of) int	Tileset's passage table.
terrain_tags	(1D array of) int	Tileset's terrain tag table.

Note : for autotiles, all values in **passages** and **terrain_tags**, therefore these fields were simplified to a *single integer value*.

Note : RMXP seem to fail to load tilesets/autotiles after an extraction with destination "Graphics\Tilesets" and "Graphics\Autotiles" directories, probably because there are foreign files in the graphic folder. For that reason, other directories were used.

- Advantages : Decoupling a **Tileset** from the autotilesets used for a particular map allows added flexibility.

6.5.1 On naming decisions

I was asked about the choice of using a numerical identifier in the file names, and why I didn't choose to use name identifiers instead. This is a decision that was taken after careful consideration :

- First of all, numerical identification was originally used for maps, tilesets, etc

Therefore, transitioning to another identification system would be complex and an exercise in reinventing the wheel, all that for questionable gain.

- Using a file name identifier means that information needs to reside inside the file itself.

Without it, some other strategy of file identification would be needed :

- Reading each file, looking for the one containing the right id
- A database associating each file with its id

Both of these aren't particularly attractive.

- The idea of using names for identification is attractive at first glance : user-friendly and intuitive, it's basically the greatest thing since sliced bread !

Unfortunately, there are some issues with this solution, including but not limited to :

- As stated before, it would be complex to transition to this new identification system.
- Not all characters are usable : every file system imposes limitations, which would impose unwanted restrictions for developers.
- Dealing with names/strings means that ids are typically longer and less formally defined (can contain more characters, including casing, accents, etc), therefore amplifying the risk of any id containing errors.
- Developers involved in this type of project are typically capable of dealing with numerical ids without issue already.
- For large projects with hundreds/thousands of maps, name collisions may force developers to use convoluted or cumbersome naming schemes.

Note that some of the issues identified may be circumvented by re-introducing the "name" field in the files themselves, but at this point the perceived value of the change would become nil.

- While it is true that numerical id collisions is possible and using name ids may help preventing them, there are other strategies available.

Planning, for example : reserving ranges of values for specific uses ahead of time.

In conclusion, it is my estimation that using numerical ids is a reasonable choice, as it is a tried-and-true that doesn't compromise on usability (at least not too much).

On the other hand, the suggestion of abandoning the 3 digit format for numerical ids was considered and adopted, as it would allow larger projects to exist and didn't pose any technical problem.

7 Remarks

7.1 Contact

Contact the author by email : David.Rodriguez.1@etu.unige.ch

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