

# Diesel Engine

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# SystemFS

SystemFS is a class to read and write files and more.

Currently, it works only in the Windows version of the game.

I'll add more info later right now I'll just list the functions and their parameters.

## Functions:

`open(path, flags)`

`close(file)`

`exists(path)`

`is_dir(path)`

`system_path(path)`

`parse_xml(path)`

`make_dir(path)`

`delete_file(path)`

can delete a folder also.

# list(dir, directories)

returns a table of files by default and folders if directories parameter is true

# copy\_file(from, to)

# copy\_files\_async(files, callback)

each file needs to be inside the files table so for example if I want to move file x to path y it's gonna be: `SystemFS:copy_files_async({"x", "y"})` the callback has two parameters - success and message if the copy failed then success will be false and message should say something.

# can\_write\_to(path)

# checksum(path)

# Bundle File

**\*Originally written by Simon W.**

## Bundle Database (BLB)

The Bundle Database file, also known as “bundle\_db.blb” and “all.blb”, defines all file entries with their hashed path, hashed extension, language, and a unique ID. Special things to note: “idstring\_lookup.idstring\_lookup” has an ID that is equal to the count of file entries.

## File structure of the .blb format

### Header

```
uint32 languages_tag //Payday 2 = "8C F2 18 00" Payday: The Heist = "9C 2B F2 00"
uint32 languages_count
uint32 languages_count //should be same value as previous uint32
uint32 languages_offset //offset to the beginning of languages section
uint32 unknown
uint32 unknown
uint32 unknown
uint32 file_entries_count
uint32 file_entries_count //should be same value as previous uint32
uint32 file_entries_offset //offset to the beginning of file entries section
uint32 unknown
uint32 unknown
uint32 unknown
uint32 unknown
```

### Languages section

```
FOREACH( languages_count )  
    uint64 language_hash  
    uint32 language_representation  
    uint32 unknown  
END FOREACH
```

## File entries section

```
FOREACH( file_entries_count )  
    uint64 file_entry_extension_hash  
    uint64 file_entry_path_hash  
    uint32 file_entry_language //one of the language representations  
    uint32 unknown  
    uint32 file_entry_ID  
    uint32 unknown  
END FOREACH
```

# Packages (bundles)

Bundles are diesel's packages containing files with corresponding IDs. The package name can be looked up with Bundle Modder by using the hash converter on the bundle name with “use hex” and “swap endianness” (this does not work with all\_x bundles).

Which then can be used in lua to load packages. Bundles are split into two files, header and data. The header files end with “\*\_h.bundle” while data files end with “\*.bundle”.

## File structure of the \_h.bundle (Header)

### Header section

```
uint32 section_size  
uint32 section_tag //Since update 70, this tag is present in every file. Payday: The Heist is present only if bundle
```

```

is all_x
uint32 file_entries_count
uint32 file_entries_count //should be same value as previous uint32
uint32 file_entries_offset //if section_tag == "00 00 00 00" then file_entries_offset += 4

uint32 file_entries_tag //Payday 2 = "E8 EB 18 00" Payday: The Heist = "88 EE 18 00"
FOREACH( file_entries_count )
    uint32 file_entry_ID
    uint32 file_entry_address //address within the *.bundle file
    IF bundle is all_x then
        uint32 file_entry_length //the length of this file entry
    END IF
END FOREACH

```

## Footer section

Please note that footer items correspond to the header file\_entries in same order.

```

uint32 section_tag //Payday 2 and Payday: The Heist = "F8 C5 FC EB"
uint32 section_size
uint32 section_item_count
uint32 unknown
uint32 unknown
uint32 unknown //tag?
FOREACH( section_item_count )
    uint64 item_extension_hash
    uint64 item_path_hash
    uint32 unknown //end tag?
END FOREACH
uint32 zero //end

```

## File structure of the h.bundle (Data)

This file consists of a collection of files. Each file entry starts at a specified address in header with a specified length, if length is not specified then it is calculated as a difference between current entry

address and next.

```
FOREACH( file_entries_count )  
  byte[] file_entry  
END FOREACH
```

# Unit File

This is an explanation of how units work in Payday 2. This may not be 100% perfect, but it should give the basic idea of what's going on.

A “unit” in Payday 2 is an object like a mask or an enemy. It basically sets properties, applies effects, and specifies textures for the units.

## Files

- **.unit** - Points to a \*.object file for further loading data about the unit. Specifies dependencies like sounds, effects, or animations. Establishes the extensions, which consist of properties for the unit like inventory, AI, damage, movement, sounds, or interactions. Sometimes can specify a path for the .unit file that is supposed to be loaded when the unit is spawned over network. And finally can specify the location of sound sources for the unit.
- **.object** - Points to a **.material\_config** file, **.sequence\_manager** file and the animations. For some units, there are “bodies” that establish which parts of bodies are enabled, and sets properties for them like friction, collision class, and a template. Then, there are “constraints”, which mostly establish how far limbs can rotate. After that, “decal\_surfaces” are established, which basically assigns a specific decal material to parts of bodies. And finally, “graphics” are specified, they set which parts of model are enabled, and sometimes sets a LOD for them depending on distance from the unit.
- **.model** - This is the model for the unit.
- **.material\_config** - Contains a list of materials with specified templates that are applied to the textures. Points to \*.texture files to use for reflections, diffused textures and normal maps.
- **.cooked\_physics** - Not much is known about this file but it is related to physics of the unit.
- **.sequence\_manager** - This file contains sequences which can be run on the unit.
- **.texture** - This is a renamed **.dds** texture file.

## Loading Order

Units in Payday are loaded in a specific order. If a file in this chain has an error, the unit will not work correctly and potentially crash the game.

The loading order is as follows: .unit file is loaded first (this file has to point to the .object file to load it next), next the .object file is loaded (this file often points to the .material\_config file, which contains textures for the model to use), next either .model or .material\_config is loaded (.material\_config has specified texture files that it loads and applies a specific template with effects to them. And .model contains the model and retrieves materials from the .material\_config).

# .unit Details

The .unit file is the first to get loaded when accessing the unit. This file is in .xml format, with a fairly simple structure. Most of the things in these .unit files are pretty self explanatory. However, the weapon units, mask units, and character units are all different. As they are obviously none of them are the same at all! Here is a sample of a .unit file.

## Sample Breakdown of a .unit file

As an example, I will be looking at the cloaker's (spook's) unit files. First, the .unit file of a cloaker are located at (units\payday2\characters\ene\_spook\_1\ene\_spook\_1.unit).

```
<unit type="being" slot="12">
  <anim_state_machine name="anims/units/enemies/cop/cop_machine" />
  <object file="units/payday2/characters/ene_spook_1/ene_spook_1" />

  <dependencies>
    <depends_on animation_state_machine="anims/units/enemies/cop/cop_machine"
animation_def="anims/units/enemies/cop/cop_def" />
    <depends_on bnk="soundbanks/regular_vox" />
    <depends_on effect="effects/particles/character/cloaker_goggle" />
    <depends_on unit="units/payday2/characters/ene_acc_baton/ene_acc_baton" />
  </dependencies>

  <extensions>
    <extension name="unit_data" class="ScriptUnitData" />
    <extension name="base" class="CopBase" >
      <var name="_tweak_table" value="spoo" />
      <var name="_default_weapon_id" value="mp5_tactical" />
    </extension>
    <extension name="inventory" class="CopInventory" />
    <extension name="brain" class="CopBrain" />
  </extensions>
</unit>
```

```

<extension name="anim_data" class="PlayerAnimationData" />
<extension name="character_damage" class="CopDamage">
  <var name="_head_body_name" value="head" />
  <var name="_death_sequence" value="kill_spook_lights" />
</extension>
<extension name="movement" class="CopMovement" >
  <var name="_footwear" value="boots" />
  <var name="_anim_global" value="cop" />
</extension>
<extension name="interaction" class="IntimateInteractionExt" >
  <var name="tweak_data" value="intimidate" />
</extension>
<extension name="network" class="NetworkBaseExtension" />
<extension name="damage" class="UnitDamage" >
  <var name="_skip_save_anim_state_machine" value="true" />
</extension>
<extension name="contour" class="ContourExt" />
<extension name="sound" class="CopSound" />
</extensions>

<network sync="spawn" remote_unit="units/payday2/characters/ene_spook_1/ene_spook_1_husk"/>

<sounds>
  <default_soundsource source="Hips"/>
</sounds>
</unit>

```

Please notice the structure: anim\_state\_machine, then object, then dependencies, then extensions, then network, then sounds. Sometimes, if this structure is not followed, the game will crash. (Note, Payday: The Heist sometimes does not follow this structure, so PD1 .unit files would often result in a crash).

Let's breakdown this file by sections.

```
<unit type="being" slot="12">
```

The first section states that this unit is a human being (I am assuming when you hit it, blood will come out). And that it's in slot 12 (I believe slot number can be ignored).

```
<anim_state_machine name="animations/enemies/cop/cop_machine" />
```

The second section establishes the animations that this unit will use. In this case, the cloaker will be using cop animations.

```
<object file="units/payday2/characters/ene_spook_1/ene_spook_1" />
```

The third line establishes where the next file is, the .object file. This file will be loaded after the .unit (Please note that the path does not contain an extension, the game already knows that you pointed at a .object file.

```
<dependencies>
  <depends_on animation_state_machine="anims/units/enemies/cop/cop_machine"
animation_def="anims/units/enemies/cop/cop_def" />
  <depends_on bnk="soundbanks/regular_vox" />
  <depends_on effect="effects/particles/character/cloaker_goggle" />
  <depends_on unit="units/payday2/characters/ene_acc_baton/ene_acc_baton" />
</dependencies>
```

This block of code establishes the dependencies that this unit has. This unit is dependent on the cop animations using the cop animation definitions. Next, this unit is dependent on the sound bank “soundbanks/regular\_vox” (this soundbank is related to speech). Next, this unit is dependent on an effect, the “effects/particles/character/cloaker\_goggle”, in the .object file this effect will be assigned to a specific location. And finally, this unit is dependent on another unit “units/payday2/characters/ene\_acc\_baton/ene\_acc\_baton” (this counts as an enemy accessory, thus the name “ene\_acc”). And once again, not a single path has an extension, the game knows.

```
<extensions>
  <extension name="unit_data" class="ScriptUnitData" />
  <extension name="base" class="CopBase" >
    <var name="_tweak_table" value="spook" />
    <var name="_default_weapon_id" value="mp5_tactical" />
  </extension>
  <extension name="inventory" class="CopInventory" />
  <extension name="brain" class="CopBrain" />
  <extension name="anim_data" class="PlayerAnimationData" />
  <extension name="character_damage" class="CopDamage">
    <var name="_head_body_name" value="head" />
    <var name="_death_sequence" value="kill_spook_lights" />
  </extension>
  <extension name="movement" class="CopMovement" >
    <var name="_footwear" value="boots" />
    <var name="_anim_global" value="cop" />
  </extension>
```

```

<extension name="interaction" class="IntimateInteractionExt" >
    <var name="tweak_data" value="intimidate" />
</extension>
<extension name="network" class="NetworkBaseExtension" />
<extension name="damage" class="UnitDamage" >
    <var name="_skip_save_anim_state_machine" value="true" />
</extension>
<extension name="contour" class="ContourExt" />
<extension name="sound" class="CopSound" />
</extensions>

```

This chunk of code assigns basic unit things, like AI, inventory, sounds, etc. Most of them stay the same, but variables change. The “unit\_data” extension is present practically in every .unit file and does not seem to change. The “base” extension is usually present on characters or usable objects. In “base” the class changes depending on the unit, and the variables in the extension also change. For this unit, the variables set the identity of this unit as “spooc” and assigns it “mp5\_tactical” as a default weapon. The “inventory” seems to be only present on units that can carry items (like ammo or other weapons). The class usually stays as “CopInventory”, but there could be multiple kinds of “inventory”. The “brain” assigns AI to the unit, in this case “CopBrain” is assigned. The “anim\_data” is currently unknown to me, but I am guessing that these are the kinds of animations a unit can perform, “PlayerAnimationData” is assigned. The “character\_damage” assigns various things regarding the damage the unit will take, “CopDamage” is assigned. Two variables are assigned as well, “\_head\_body\_name” signifies what part of body (according to model) is considered to be the head, the “\_death\_sequence” signifies what sequence this unit will perform at death. The “movement” assigns what kind of movement this unit will perform, “CopMovement” is assigned, as well as two other variables. The first variable “\_footwear” states what kind of shoes the unit will have, “boots” are assigned. Second variable “\_anim\_global” states what kind of movement animations this unit will perform, “cop” animations are assigned. The “interaction” is usually present with units that can be interacted with, I am lacking detail as to what kind of interaction, “IntimateInteractionExt” is assigned, with one variable. The variable “tweak\_data” is pretty much always present with “interaction”, “intimate” is assigned. The “network” extension is usually present on units that can be spawned or changed during the game, “NetworkBaseExtension” is assigned. The “damage” extension is usually present with units that can deal damage, “UnitDamage” is assigned with one variable. The variable “\_skip\_save\_anim\_state\_machine” is related to animations and I am unsure about the exact usage of this, variable is set to “true”. The “contour” extension is usually present with units that can have an outline, class of “ContourExt” is assigned. The “sound” extension determines what kind of sounds this unit can make, “CopSound” is assigned.

```

<network sync="spawn" remote_unit="units/payday2/characters/ene_spooc_1/ene_spooc_1_husk"/>

```

This section is usually present with units that can be spawned or changed during the game. This is responsible for syncing the spawn, by specifying the .unit file to be loaded on the clients. (Lobby host does not use this, only the client).

```
<sounds>
  <default_soundsource source="Hips"/>
</sounds>
```

This section specifies the source of sound for the unit. Apparently the cloaker (and all other enemies) make sounds from their “Hips”.

After the .unit file is loaded, the .object gets loaded. Not all commands were listed in this example, so other commands will be listed below in the “Other .unit commands” section with their explanations.

## Other .unit commands

Other .unit commands will be added here as research progresses.

## .object Details

The .object file is second to get loaded when accessing the unit. This file is in .xml format, with a fairly simple structure. Most of the things in these .object files are pretty self explanatory, and about 80% unique to the unit, as it heavily relies on the model and the names of body parts in the model. The .object file usually contains properties of model parts like materials, sequence\_manager, bodies, constraints, effects, graphics, and lights. Here is a continuation of the unit breakdown from previous section.

## Sample Breakdown of a .object file

Following from the previous section, the .object file path of a cloaker was assigned as “units/payday2/characters/ene\_spook\_1/ene\_spook\_1” (that's without the .object at the end). The .object files tend to be repetitive, as they assign each “body” in a model, specific settings. And for sake of space, the .object file will be cut down to include as little repetition as possible.

```
<dynamic_object>
  <diesel materials="units/payday2/characters/ene_spook_1/ene_spook_1" orientation_object="root_point" />
  <sequence_manager file="units/payday2/characters/ragdoll" /> <animation_def
name="anims/units/enemies/cop/cop_def" />

  <bodies>
```

```

<body name="body" enabled="true" template="character" friction="0.6" collision_class="ragdoll">
  <object name="Spine1"/>
  <object name="c_capsule_body" collision_type="capsule"/>
</body>

<body name="mover_blocker" enabled="true" template="mover_blocker" keyframed="true"
collision_class="ragdoll">
  <object name="root_point"/>
  <object name="c_capsule_mover_blocker" collision_type="capsule"/>
</body>

  ***PART OF THE FILE WAS SNIPPED HERE***

<!-- RAGDOLL -->

  <body name="rag_Head" enabled="false" template="corpse" friction="0.01" sweep="true"
collision_class="ragdoll" keyframed="false" collision_script_quiet_time="0.5" collision_script_tag="small"
ray="block" lin_damping="0.6" ang_damping="20" collides_with="0" tag="flesh" restitution="0">
  <object name="Neck" />
  <object collision_type="sphere" mass="4" padding="-15" name="c_sphere_head_ragdoll"/>
</body>

  <body name="rag_Hips" enabled="false" template="corpse" friction="0.6" sweep="true"
collision_class="ragdoll" keyframed="false" collision_script_quiet_time="0.5" collision_script_tag="large"
ray="block" lin_damping="0.4" ang_damping="20" collision_group="1" collides_with="0" tag="flesh"
restitution="0">
  <object name="Hips" />
  <object collision_type="capsule" mass="22" padding="-5" name="c_sphere_Hips" />
</body>

  ***PART OF THE FILE WAS SNIPPED HERE***
</bodies>

<constraints>
  <constraint type="ragdoll" name="RightArm" enabled="false">
    <param body_a="rag_Spine2" body_b="rag_RightArm"/>
    <param pivot="position:RightArm"/>
    <param twist_axis="yaxis:RightArm" twist_min="-60" twist_max="70" twist_freedom="20"/><!-- X axis --
>
    <param plane_axis="xaxis:RightArm"/><!-- Y axis -->
    <param cone_y="35" cone_z="40" cone_freedom="10"/>
    <param damping="1" spring_constant="200" min_restitution="0"/>
  </constraint>

```

```

<constraint type="limited_hinge" name="RightForeArm" enabled="false">
  <param body_a="rag_RightArm" body_b="rag_RightForeArm"/>
  <param pivot="position:RightForeArm"/>
  <param min_angle="-60" max_angle="60" axis="yaxis:RightForeArm" twist_freedom="5"/> <!-- X axis --
>
  <param plane_axis="xaxis:RightForeArm"/> <!-- Y axis -->
  <param damping="1" spring_constant="200" min_restitution="0"/>
</constraint>
***PART OF THE FILE WAS SNIPPED HERE***
</constraints>

<decals default_material="flesh" />

<effects>
  <effect_spawner name="es_light" enabled="false" object="e_light"
effect="effects/particles/character/cloaker_goggle" />
</effects>

<graphics>
  <graphic_group name="character" enabled="true" culling_object="g_body">

    <lod_object name="lod_body">
      <object name="g_body" [ ]enabled="true" max_distance="3000" max_draw_lod="0" />
      <object name="g_body_lod1" [ ]enabled="true" lod="1" />
    </lod_object>

    <object name="s_body" enabled="true" shadow_caster="true"/>

    <object name="g_il" [ ]enabled="false" />

  </graphic_group>
</graphics>

<lights>
  <light name="point_light" enabled="false" multiplier="reddot" far_range="25" near_range="1" falloff="4.0"
type="omni|specular" />
</lights>

</dynamic_object>

```

Please notice the structure: diesel materials, then sequence\_manager, then animation\_def, then bodies, then constraints, then decal\_surfaces, then effects, then graphics, and then lights. Sometimes, if this structure is not followed, the game will crash. (Note, Payday: The Heist sometimes does not follow this structure, so PD1 .object files would often result in a crash).

Like before, Let's breakdown this file by sections.

```
<diesel materials="units/payday2/characters/ene_spook_1/ene_spook_1" orientation_object="root_point" />
```

This section specifies the location of the the .material\_config file, along with the orientation position. This is present in most units that have a model (some weapons don't seem to specify this). The .material\_config file is specified to be "units/payday2/characters/ene\_spook\_1/ene\_spook\_1" (once again, no .material\_config, game knows) with the orientation at "root\_point" of the model.

```
<sequence_manager file="units/payday2/characters/ragdoll" />` `<animation_def  
name="anim/units/enemies/cop/cop_def" />
```

This section specifies what sequence\_manager file to use. And what animations to use. (Sometimes these are separated into two lines). The sequence\_manager file is specified to be located at "units/payday2/characters/ragdoll" (no .sequence\_manager extension). And the "anim/units/enemies/cop/cop\_def" animation definition is set to be used.

```
<bodies>  
  <<body name="body" enabled="true" template="character" friction="0.6" collision_class="ragdoll">  
    <<<object name="Spine1"/>  
    <<<object name="c_capsule_body" collision_type="capsule"/>  
    <</body>  
    <<body name="mover_blocker" enabled="true" template="mover_blocker" keyframed="true"  
collision_class="ragdoll">  
      <<<object name="root_point"/>  
      <<<object name="c_capsule_mover_blocker" collision_type="capsule"/>  
      <</body>  
      ***PART OF THE FILE WAS SNIPPED HERE***  
  
    <!-- RAGDOLL -->  
    <<body name="rag_Head" enabled="false" template="corpse" friction="0.01" sweep="true"  
collision_class="ragdoll" keyframed="false" collision_script_quiet_time="0.5" collision_script_tag="small"  
ray="block" lin_damping="0.6" ang_damping="20" collides_with="0" tag="flesh" restitution="0">  
      <<<object name="Neck" />  
      <<<object collision_type="sphere" mass="4" padding="-15" name="c_sphere_head_ragdoll"/>  
      <</body>
```

```

<body name="rag_Hips" enabled="false" template="corpse" friction="0.6" sweep="true"
collision_class="ragdoll" keyframed="false" collision_script_quiet_time="0.5" collision_script_tag="large"
ray="block" lin_damping="0.4" ang_damping="20" collision_group="1" collides_with="0" tag="flesh"
restitution="0">
  <object name="Hips" />
  <object collision_type="capsule" mass="22" padding="-5" name="c_sphere_Hips" />
</body>

  ***PART OF THE FILE WAS SNIPPED HERE***

</bodies>

```

This section pretty much defines collisions and ragdolls per body parts in the model. For the first “body” is enabled (as it's set to true), the template for “character” is used with friction of “0.6”, and a collision class of “ragdoll”. This seems to include the object “Spine1” and “c\_capsule\_body” of collision type “capsule”. Both of those objects are most likely defined in the .model file. **THIS IS NOT FINISHED!!!**

```

<constraints>
  <constraint type="ragdoll" name="RightArm" enabled="false">
    <param body_a="rag_Spine2" body_b="rag_RightArm"/>
    <param pivot="position:RightArm"/>
    <param twist_axis="yaxis:RightArm" twist_min="-60" twist_max="70" twist_freedom="20"/><!-- X axis -->
    <param plane_axis="xaxis:RightArm"/><!-- Y axis -->
    <param cone_y="35" cone_z="40" cone_freedom="10"/>
    <param damping="1" spring_constant="200" min_restitution="0"/>
  </constraint>

  <constraint type="limited_hinge" name="RightForeArm" enabled="false">
    <param body_a="rag_RightArm" body_b="rag_RightForeArm"/>
    <param pivot="position:RightForeArm"/>
    <param min_angle="-60" max_angle="60" axis="yaxis:RightForeArm" twist_freedom="5"/> <!-- X axis -->
    <param plane_axis="xaxis:RightForeArm"/> <!-- Y axis -->
    <param damping="1" spring_constant="200" min_restitution="0"/>
  </constraint>

  ***PART OF THE FILE WAS SNIPPED HERE***

</constraints>

```

This section deals with constraints of rotations and movement. **THIS SECTION NEEDS MORE EXPLANATION, BUT IS SELF EXPLANATORY!!!**

```
<decal_surfaces default_material="flesh" />
```

This little section states that the default material for the unit is “flesh”. There are a few other default materials besides flesh, and sometimes they're even applied per body part in this section.

```
<effects>
  <effect_spawner name="es_light" enabled="false" object="e_light"
  effect="effects/particles/character/cloaker_goggle" />
</effects>
```

This section applies effects to the unit. I am not 100% certain on the application process. I believe that the effect under the name “es\_light” is being applied to the object “e\_light” (probably stated in .model) from effect file “effects/particles/character/cloaker\_goggle” (once again, .effect extension is not needed).

The name of the effect does not matter; it can be set to anything you want. It seems to be only for referential purposes. The effect does not necessarily need to be applied to an "e\_light" object, as other objects in the file will work as well (such as "g\_body" or "root\_point").

```
<graphics>
  <graphic_group name="character" enabled="true" culling_object="g_body">

    <lod_object name="lod_body">
      <object name="g_body" enabled="true" max_distance="3000" max_draw_lod="0" />
      <object name="g_body_lod1" enabled="true" lod="1" />
    </lod_object>

    <object name="s_body" enabled="true" shadow_caster="true"/>

    <object name="g_il" enabled="false" />

  </graphic_group>
</graphics>
```

In this section, there are two things happening. First, the LOD is being set per distance (in centimeters). So at distance < 3000 cm the default LOD model will be drawn to screen. If distance > 3000 cm then the LOD1 will be drawn. Second, some elements of the model are enabled/disabled in this section. As you can see, the “s\_body” is enabled (with “true”) and is set to cast a shadow with shadow\_caster set to “true”. And then there is “g\_il” which is disabled. Please note that not all elements of the .model can be disabled here. Only the ones you know (i.e. the ones already listed in this .object file) or the ones you know from the model (currently there is no way of looking up element names from models).

```
<lights>
  <light name="point_light" enabled="false" multiplier="reddot" far_range="25" near_range="1" falloff="4.0"
  type="omni|specular" />
</lights>
```

This section is for creating a light on the unit. For this unit in particular, it creates a glow around them that gets enabled via the sequence\_manager. This “point\_light” has a range of 1 - 25 with the falloff of “4.0” (I think the falloff is for the type) and type of “omni|specular”. I am not certain about what this type specifically does, but it certainly acts as an effect on this “point\_light”.

After the .object file is loaded, either the .model or the .material\_config file get loaded. Not all commands were listed in this example, so other commands will be listed below in the “Other .object commands” section with their explanations.

## Other .object commands

Other .object commands will be added here as research progresses.

## .model Details

Currently there are no details on the .models, as the filetype has not been completely reverse engineered.

Research Notes:

.model contains hashed names of objects using Hash64, uint64. (Currently looking into editing elements)

Bones have been redone since Payday:`` ``The`` ``Heist , they now don't include 4th elements of fingers.

Each bone is specified as a 3D Object, which contains rotation matrix, position, and a parent ID.

Observations:

\*It's near impossible to find model names, as they are hashed and unhashing them would be near impossible. They are not part of idstring.

\*I'm assuming .material\_config hashes the name of material, and applies it to the model. If it doesn't exist, it still applies (to nothing).

\*It would be easier to create models from scratch, as you will know the names of all objects and materials, so you would have full control over the model.

## .material\_config Details

The .material\_config file is loaded sometime after the .object file. This file is in .xml format, with a fairly simple structure. Most of the things in these .material\_config files are pretty self explanatory, and is unique to the unit, as it heavily relies on the model and the names of body parts in the model. The .material\_config file contains texture paths (diffused and bump map textures), sometimes reflection textures, sometimes material\_textures, and sometimes some variables for the render\_template. Here is a continuation of the unit breakdown from previous section.

# Sample Breakdown of a .material\_config file

In this example we will be using the cloaker. The .material\_config file path of a cloaker was assigned as "units/payday2/characters/ene\_spook\_1/ene\_spook\_1" (that's without the .material\_config at the end). The .material\_config files tend to be repetitive, as they assign each the requested material names in the model, specific textures and effects. And for sake of space, the .material\_config file will be cut down to include as little repetition as possible.

```
<materials version="3" group="ene_spook_1">
  <material name="mtr_body"
render_template="generic:DIFFUSE_TEXTURE:NORMALMAP:RL_COPS:SKINNED_3WEIGHTS" version="2">
    <bump_normal_texture [ ]file="units/payday2/characters/shared_textures/spook_heavy_nm"/>
    <diffuse_texture [ ]file="units/payday2/characters/shared_textures/spook_heavy_df"/>
  </material>
  <material name="mtr_il"
render_template="generic:ALPHA_MASKED:DIFFUSE_TEXTURE:OPACITY_TEXTURE:RL_COPS:SELF_ILLUMINATION"
version="2">
    <diffuse_texture [ ]file="units/payday2/characters/shared_textures/spook_il"/>
    <self_illumination_texture [ ]file="units/payday2/characters/shared_textures/spook_il"/>
    <opacity_texture [ ]file="units/payday2/characters/shared_textures/spook_il"/>
    <variable [ ]value="reddot" type="scalar" name="il_multiplier"/>
  </material>
  <material name="shadow_caster" render_template="shadow_caster_only:SKINNED_1WEIGHT" version="2"/>
</materials>
```

There is no specific structure to follow. This file seems to be a list of materials with some variables attached. The only real problems that can occur are incorrect textures, broken model, no model at all (but a floating blob of gray).

Let's breakdown this file by sections.

```
<materials version="3" group="ene_spook_1">
```

This establishes the group that these materials belong to. I am not sure as to what group names can be given, but it's best to keep them similar to the original model names. The version does not seem to matter.

```
<material name="mtr_body"
render_template="generic:DIFFUSE_TEXTURE:NORMALMAP:RL_COPS:SKINNED_3WEIGHTS" version="2">
  <bump_normal_texture [ ]file="units/payday2/characters/shared_textures/spook_heavy_nm"/>
  <diffuse_texture [ ]file="units/payday2/characters/shared_textures/spook_heavy_df"/>
</material>
```

This section identifies a material “mtr\_body” with a render\_template of “generic:DIFFUSE\_TEXTURE:NORMALMAP:RL\_COPS:SKINNED\_3WEIGHTS” and version of “2” (once again, does not seem to matter). The material name has to match the one listed in the .model file, otherwise the model will be broken. The render\_template is a predefined template, and **CANNOT SIMPLY BE APPENDED**, there is a list of available render\_templates with explanations [HERE](#). This material has two variables included (these are present with almost every material). The “bump\_normal\_texture” specifies where the bump map of this material is, for this example it's located at “units/payday2/characters/shared\_textures/spook\_heavy\_nm” (once again, the .texture extension is not needed). Followed by a “diffuse\_texture”, which is the actual texture of the material, located at “units/payday2/characters/shared\_textures/spook\_heavy\_df”. Both the “bump\_normal\_texture” and the “diffuse\_texture” are passed to the render\_template to be handled.

```
<material name="mtr_il"
render_template="generic:ALPHA_MASKED:DIFFUSE_TEXTURE:OPACITY_TEXTURE:RL_COPS:SELF_ILLUMINATION"
version="2">
  <diffuse_texture [ ]file="units/payday2/characters/shared_textures/spook_il"/>
  <self_illumination_texture [ ]file="units/payday2/characters/shared_textures/spook_il"/>
  <opacity_texture [ ]file="units/payday2/characters/shared_textures/spook_il"/>
  <variable [ ]value="reddot" type="scalar" name="il_multiplier"/>
</material>
```

This section right here is almost identical to the previously viewed material. To differentiate this new material, it has a different, uses a different render\_template, and has a few new variables. The diffuse texture serves the same purpose as before. The new, “self\_illumination\_texture” points to the path of “units/payday2/characters/shared\_textures/spook\_il”. This “self\_illumination\_texture” is related to the render\_template. Same with “opacity\_texture” and the “variable”. All of them are passed to to the render\_template to be handled.

```
<material name="shadow_caster" render_template="shadow_caster_only:SKINNED_1WEIGHT" version="2"/>
```

This last section is responsible for casting shadows. With name “shadow\_caster” and render\_template of “shadow\_caster\_only:SKINNED\_1WEIGHT”. A list of available render\_templates with explanations [HERE](#).

After the .material\_config file is loaded, nothing else loads. Not all commands were listed in this example, so other commands will be listed below in the “Other .material\_config commands” section with their explanations.

## Other .material\_config commands

Other .material\_config commands will be added here as research progresses.

# Skin map textures (df\_cc)

## Skin map texture

The \_cc\_df textures are used instead of diffuse on models when skin is applied and each channel controls specific aspect of it:

### Red

Red channel is used as material map for 6 defined types of it.



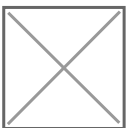
Materials shown in overkill base gradient template.



Example of PD2 Aimpoint material map layer.

### Green

Green channel seems to be mix of various maps with diffuse as main goal of this channel is to give skin a shape and details like a diffuse but with colors controlled by skin.



Example of PD2 EOTech sight.

### Blue

Blue channel is used to create "wear and tear" damage to skin as quality of skin lowers and gradient timeline progresses.



Example of wear and tear on PD2 EOTech sight.

# Creating skin textures for custom models

## Red

Material map can be either created by manually painting parts on channel or using exported UV layouts of selected meshes. Painted parts must only use solid color as any form of gradients or blending will results in artifacts.



Use these RGB color values to assign specific material:

- Metal - #000000
- Plastic - #525252
- Wood/Rubber - #5a5a5a
- Sec. Metal - #848484
- Cloth - #adadad
- Details - #efefef



## Green

Diffuse texture in grayscale can be reused for this channel. Image must be in edited be around light gray colors (Too dark image will results in missing details on models).



## Blue

For wear and tear layer any texture of scratches with transparency or on white background can be used.



Example of random texture with scratches. For best transition between skin quality scratches should have some black/white range can go fully from 0 to 255.



Black color = Part of texture that will get damaged/White = Solid. Optional: Very subtle outlines of AO map for easier visualization what parts of texture get damaged.



Preview of example texture in-game.

# Note about Payday 2 Model Tool

For GLTF/GLB format: New objects and models can include more UV layers.

- UV0 (Default "UVMap" in blender) will be used as the "pattern UV" if a second UVMap is not present.

- UV1 (Second listed UVMap in blender) will be used as the "pattern UV" for patterns and stickers when present.

For OBJ format: Not recommended to use but new objects or models are free of any problems with skins but in case of replacing existing objects in PD2 models remember to use "Pattern UV" option to prevent patterns being missing/broken in most cases.



# Additional notes about UV coordinates

Some CC textures have parts that do not utilise the skin materials and will show their original textures (Example, Commando 101 rocket launcher), this effect can be achieved by moving the pattern UVs outside of the 0-1 region.

# Animated Models

(WIP PAGE ON ANIMATED MODELS USED IN PAYDAY 2)

## Page Notes:

- Animations missing X Y or Z rotations dont seem to work properly. (tested on 32-Bit Floats with Discard)
  - Animations missing X Y or Z loations work fine.
  - Animations using scale likely dont work.

## Importing Animations

wip

## Exporting Animations

wip

## Building an animated model

wip

Object File Portion:

```
<!--Storing and Grouping Animations-->
<animations>
  <animation_group name="animation_group_name">
    <object name="anim_part_a" />
    <object name="anim_part_b" />
```

```

    </animation_group>
  </animations>

  <!--Collision/Hitboxes-->
  <bodies>
    <body name="body_anim_part_a" enabled="true" template="animated">
      <object name="anim_part_a" />
      <object name="c_c" collision_type="box" padding="-2.5"/>
    </body>
  </bodies>

```

# Sequence Manager

`animation_group` is the type of sequence you want to play animations in the model.

- enabled: Is it playing or paused (true/false)
- name: The animation group name you want to use ("string")
- from: The start of where you are playing
- to: where you want to end (not using this will make it continue until the end of the animation)

Example:

```

<sequence editable_state="true" name=""play_animation"" triggable="true">
  <animation_group enabled="true" name=""animation_group_name"" from="0/30" to="20/30"/>
</sequence>

```

# Material Config XML

Example XML:

```
<materials version="3">
  <material name="mat_name" render_template="generic:DIFFUSE_TEXTURE:NORMALMAP" version="2">
    <diffuse_texture[]file="texture/file/path/my_texture_df"/>
    <bump_normal_texture[]file="texture/file/path/my_texture_nm"/>
  </material>
</materials>
```

TEMPLATES ARE **NOT** MODULAR!

A full list of template variables can be found in `shaders/base.render_template_database`

- `<materials/>` contains all of the material xml for the file.
  - Typically uses `version="3"`
- `<material/>` contains the information of a material.
  - Typically uses `version="2"`
- `<diffuse_texture/>` a variable that often uses a texture with the identifier `_df` at the end.
- `<bump_normal_texture/>` a variable that often uses a texture with the identifier `_nm` at the end.
- `<material_texture/>` a variable that often uses a texture with the identifier `_gsma` at the end. (Gloss, Specular, Metalness, Alpha)
- `<reflection_texture/>` is a variable that loads a cubemap to a material that accepts cubemaps.
  - `<reflection_texture type="cubemap" global_texture="current_global_texture"/>` will use the Environment set cubemap.
  - `<reflection_texture type="cubemap" file="texture/file/path/my_cubemap"/>` will use a locked cubemap and wont change from environments.

## Special Use Cases

- `<material/>` control options:
  - `name="mat_name"` give your material a name to go with your models material name.
  - `render_template="template_name"` a full list of templates can be found in `shaders/base.render_template_database`
  - `unique="true"` is usually used for materials that will change per-unit. Unit contours for example.

- `src="name"` will clone the values from an existing `<material>` to your current material.
  - cloned materials can be modified further by including variables or textures to override the source copy.
- `decal_material="id"` graphic mesh faces with the material will use the `decal_material` variable for hit effects.
  - List of decal IDs can be found in `lib\tweak_data\tweakdata.lua` `self.materials = {list}`
- `diffuse_color="255 255 255 255"` potentially unused. (Red, Green, Blue, Alpha)
- `version="2"` most if not all templates use version 2.
- `<variable/>` control options:
  - Animations can control some variables using the listener type.
    - Standard variable: `<variable name="il_tint" type="vector3" value="1 1 1"/>`
    - Listener variable: `<variable name="il_tint" type="listener" value="light::color" object="lo_lightobject"/>`

# Object Xml

Example XML:

```
<dynamic_object>
  <[diesel materials="units/path/material_config" orientation_object="rp_rootpoint_object" />
  <[sequence_manager file="units/path/sequence_manager" />
  <[bodies>
    <[[body name="body_static" enabled="true" template="static">
      <[[[object name="c_collision" collision_type="box" padding="-2.5" />
    <[[/body>
  <[/bodies>
  <[
  <[decal_surfaces default_material="stone">
    <[[decal_mesh name="dm_decalmesh" enabled="true" material="steel" />
  <[/decal_surfaces>
  <[
  <[graphics>
    <[[object name="g_graphics" enabled="true" shadow_caster="true" />
  <[/graphics>
</dynamic_object>
```

- `<diesel/>` is a required table that holds a path to the materials and root object.
  - `materials="path"` leads to the material config the unit will use.
  - `orientation_object="rp_rootpoint"` the object that acts as the origin of the unit, must be an Empty object.
- `<sequence_manager file="path"/>` is its own table defining the sequence manager the unit will use.
  - **Warning!** `<extension name="damage" class="UnitDamage" />` is required in the units extensions!
- `<bodies/>` is the table that holds collision information.
- `<body/>` is the table that holds the objects that will be used as collision.
  - `name` is the name of the body you are making.
  - `enabled` is a toggle for if collision should be enabled.
  - `template` is the physics template of the body.
    - `static` is solid collision.
    - `editor` is editor only collision.
    - a full list of templates can be found in `settings/physics_settings.physics_settings`.
    - templates can be edited in object by adding properties seem in the `physics_settings` file.

- `<object/>` is the table that holds the referenced object. (The same object can be used more than once)
  - `name` is the name of the object being used.
    - Using empties will bind the body to the empty for constraints.
  - `collision_type` is the shape/type of collision.
    - `box` is a box.
    - `sphere` is a sphere.
    - `capsule` is a pill shape.
    - `convex` is a convex shape based on your used object mesh.
    - `mesh_mopp` is a paper thin collision that is 1:1 the shape of your objects mesh.
  - `two_sided` is a toggle for if your collision should be double sided. (Very buggy!)
  - `padding` is the additional thickness in cm of your object.
    - Default 0 leaves models 2.5cm thicker, use -2.5 to correct it.
    - Does not apply to mesh\_mopp collision.
- `<decal_surfaces/>` is the table that holds a list of meshes to act as decal surfaces. (Blankets that allow decals to spawn)
  - `default_material` is used if no decal material information is available when hit.
- `<decal_mesh/>` is a table that holds a specific object to act as a decal surface.
  - `name` is the name of the object being used as the decal mesh.
  - `enabled` is a toggle for if decal\_mesh should be enabled.
  - `material` to be used when shot/hit.
- `<graphics/>` is the table that holds all of the graphics objects.
  - `<object/>` is a table that is used to control the selected graphic.
    - `name` is the name of the object being used as the graphic.
    - `enabled` is a toggle for if the graphics should be visible.
    - `shadow_caster` is a toggle for if the graphics object should cast a shadow. (typically used by shadow\_caster material objects. `s_shadowcaster`)
- `<constraints/>` is a table that holds all of the constraint information.
- `<constraint/>` is a table that constrains objects together.
  - `enabled` is a toggle for if the constraint should be active.
  - `type=""` sets the type of constraint.
    - `static`
    - `ragdoll`
  - `<param body_a="body_a" body_b="body_b"/>` Attaches A to B.
    - Attaching to world requires `@world` to be used as `body_a`.
  - `<param pivot="position:a_object"/>` Sets the position to pivot from.
  - `<param twist_axis="yaxis:a_object" twist_min="-10" twist_max="10" twist_freedom="1"/>` Sets the twist axis and control.
  - `<param plane_axis="xaxis:a_object"/>`
  - `<param cone_y="60" cone_z="60" cone_freedom="12"/>` Limit the angle the constraint can rotate.
  - `<param damping="8" spring_constant="600" min_restitution="0"/>` Spring settings.

# Sequence Manager XML

## Unit extension

```
<extension name="damage" class="UnitDamage" />
```

## Include in object file

```
<sequence_manager file="path to your sequence manager" />
```

Example XML:

```
<table>
  <unit>
    <sequence editable_state="true/false" name="" triggerable="true/false">

  </sequence>
</unit>
</table>
```

**Important:** Strings need to have `'` at the beginning and end, otherwise they do not work.

## Sequences

- `<sequence/>`
  - `name` The name of your sequence. This will show up in the mesh variation dropdown and UnitSequence/UnitSequenceTrigger elements.
  - `editable_state` Makes the sequence show up in the mesh variation dropdown and UnitSequence element. \*
  - `triggerable` Makes the sequence show up in the UnitSequenceTrigger element \*
  - Both `editable_state` and `triggerable` are optional. Sequences will run and trigger without them, you just have to type in the sequence name manually into the elements.
  - ***\*That's probably how it's supposed to work, however testing showed that having either of them set to true will make it show in both***

## ***UnitSequence and UnitSequenceTrigger, as well as the mesh variation dropdown.***

- `once` true / false | Sequence can only run once.
- `<object/>` Used to toggle individual graphic objects.
  - `name` Name of the object. Usually start with "g\_".
  - `enabled` true / false
- `<graphic_group/>` Used to toggle graphic groups.
  - `name` Name of the graphic group.
  - `visibility` true / false
- `<body/>` Used to toggle bodies/collisions.
  - `name` Name of your body.
  - `enabled` true / false
- `<decal_mesh/>` Used to toggle decal meshes.
  - `name` Name of your decal mesh. Usually start with "dm\_".
  - `enabled` true / false
- `<light/>` Used to toggle lights.
  - `name` Name of your light object.
  - `enabled` true / false
- `<material_config/>` Used to change the material config of your unit.
  - `name` path to the new .material\_config you want to apply.
- `<sound/>` Used to play sounds from your unit.
  - `action` play / stop
  - `event` ID of the sound you want to play.
  - `object` Source object the sound is played from.
  - `source` Alternative to `object`, use a soundsource which has been defined in the .unit file.
- `<effect/>` Used to play effects from your unit.
  - `name` Path to the effect you want to play. Example: `name=""effects/particles/explosions/explosion_grenade""`
  - `parent` object you want to play the effect from. Example: `parent="object( 'smoke' )"`
  - `position` (Not sure what it does exactly, every effect I found had `position="v()"` in it too)
- `<animation_group/>` Plays an animation.
  - `enabled` true / false
  - `name` Name of your animation group.
  - `from` The frame that this animation should start on. Example: `from="0/30` will make the animation play at 30fps.
  - `to` End frame of your animation. Example: `to="64/30`
  - `speed` How fast your animation is playing. 1 is normal speed, can be a negative value to play backwards.
- `<run_sequence/>` Used to run another sequence.
  - `name` The name of the sequence you want to run.
- `<spawn_unit/>` Spawns a new unit.
  - `name` Path to the unit you want to spawn.

- `position` Object position, usually an empty, that the unit will be spawned on.  
Example: `position="object_pos('spawn_doors')"`
- `rotation` Same as position, but for rotation. Example:  
`rotation="object_rot('spawn_doors')"`
- `<interaction/>` Toggle interactions on your unit.
  - `enabled` true / false
- `start_time` can be used on pretty much everything to add delays.
- `startup` true / false

## Hitboxes

You can take any body from your .object and use it as a hitbox to trigger sequences.

```
<table>
  <unit>
    <body name="">
      <endurance>
        <run_sequence name=""/>
      </endurance>
    </body>
  </unit>
</table>
```

- `<body/>` This defines a body from your .object as a hitbox.
  - `name` The name of the body.
  - `<endurance/>` Controls how much damage the hitbox can take before it triggers the sequences inside.
    - `bullet` How many times you need to shoot it.
    - `explosions` How many explosions you need.
    - `melee` How many melee hits you need.
    - `lock` Doors, deposit boxes and basically anything you can use a saw on use this. (For Example: `lock="15"` on deposit boxes.)

## Filters and Variables

You can define variables and filter sequences based on the value of a variable.

```
<table>
  <unit>
```

```

<variables>
  <your_variable_name value="#"/>
</variables>

<filter name="'your_filter_name'">
  <check value="vars.your_variable_name == #"/>
</filter>
</unit>
</table>

```

Add `filter="your_filter_name"` to a sequence to make it only run if the variable and the filter have the same value.

Use `<set_variables your_variable_name="#"/>` to change variable values.

## Example:

```

<table>
  <unit>
    <variables>
      <var_loot_type value="0"/>
    </variables>

    <filter name="'loot_money'">
      <check value="vars.var_loot_type == 1"/>
    </filter>

    <filter name="'loot_gold'">
      <check value="vars.var_loot_type == 2"/>
    </filter>

    <sequence editable_state="true" name="'set_loot_money'" triggable="true">
      <set_variables var_loot_type="1"/>
    </sequence>

    <sequence editable_state="true" name="'set_loot_gold'" triggable="true">
      <set_variables var_loot_type="2"/>
    </sequence>

    <sequence editable_state="true" name="'spawn_loot'" triggable="true">
      <spawn_unit filter="'loot_money'"
name="'units/pd2_dlc1/vehicles/str_vehicle_truck_gensec_transport/spawn_deposit/spawn_money'.../>
    </sequence>
  </unit>
</table>

```

```
<spawn_unit filter=""loot_gold""  
name=""units/pd2_dlc1/vehicles/str_vehicle_truck_gensec_transport/spawn_deposit/spawn_gold"".../>  
</sequence>  
  
</unit>  
</table>
```

To be continued...

## (old notes from rex)

Vector3 form in sequence manager: `v(0, 0, 0)`

### MaterialElement

- `<material/>` material sequences affect materials of the functioning unit. `Unique="true"` is required to only affect this unit.
  - `name` is the name of the material you are modifying.
  - `time` set the time of animated materials, Joys mask uses this feature.
  - `state` sets a state argument, Joys mask uses this feature to pause the UV scrolling.
  - `render_template` sets the render template.
  - `glossiness` sets the glossiness value.
  - If you use a custom `key="value"` you can affect material config elements on your own.
    - Example: `<material name=""mat_mat"" il_multiplier="10"/>`
    - This will modify the `il_multiplier` of an illuminated material.
    - Vector3 values need to be written like so `key="v(1, 2, 3)"`

---

pick random sequence thingy `<run_sequence name=""sequence_'.pick('1','2','3')"`