

Project

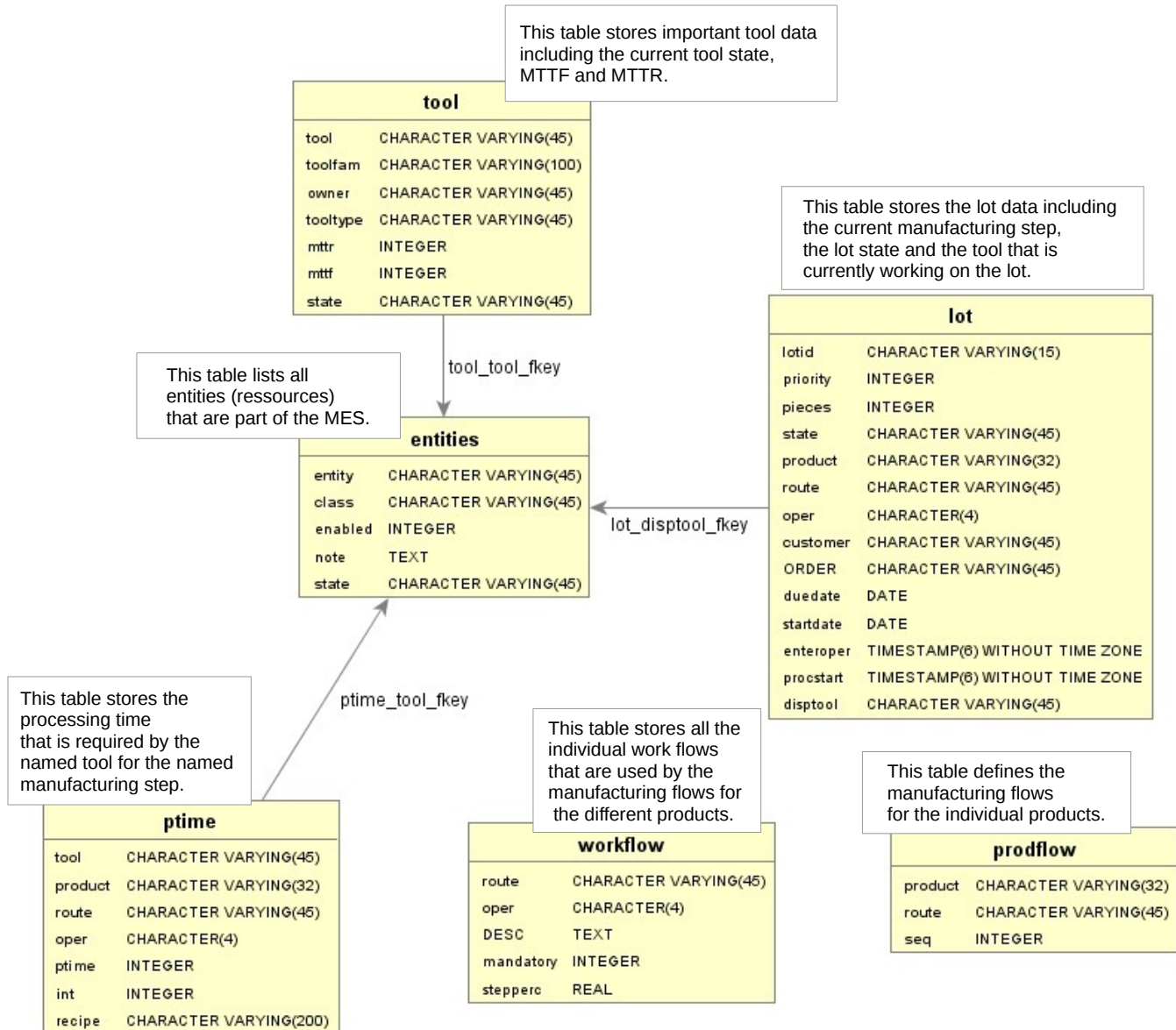
Cinderella

HTW Dresden, Department of Mathematics and Computer Science

Design document for

VWP Data base

Essential MES data base tables for basic manufacturing



Advanced MES data base tables for manufacturing

This table is used to define tool dedication for lots at dedicated manufacturing operations.

tooldedication	
lotid	CHARACTER VARYING(15)
product	CHARACTER VARYING(32)
route	CHARACTER VARYING(45)
oper	CHARACTER(4)
forcedtools	TEXT
forbiddentools	TEXT
requestor	CHARACTER VARYING(45)
notes	TEXT
timestamp	TIMESTAMP(6) WITHOUT TIME ZONE

This table stores current task data for tools connected via STI.

taskrepo	
id	CHARACTER VARYING(200)
state	CHARACTER VARYING(45)
timestamp	TIMESTAMP(6) WITHOUT TIME ZONE
json	TEXT

This table is used to schedule events for entities.

schedevents	
entity	CHARACTER VARYING(45)
event	CHARACTER VARYING(45)
due	TIMESTAMP(6) WITHOUT TIME ZONE
executed	TIMESTAMP(6) WITHOUT TIME ZONE
requestor	CHARACTER VARYING(45)
notes	TEXT

This table is used to define hold operations or times for individual lots.

lothold	
lotid	CHARACTER VARYING(15)
route	CHARACTER VARYING(45)
oper	CHARACTER(4)
active	TIMESTAMP(6) WITHOUT TIME ZONE
requestor	CHARACTER VARYING(45)
notes	TEXT
timestamp	TIMESTAMP(6) WITHOUT TIME ZONE

Primary MES data base tables for reporting

events	
timestamp	TIMESTAMP(6) WITHOUT TIME ZONE
event	CHARACTER VARYING(45)
entity	CHARACTER VARYING(45)
note	TEXT

This table represents the MES event trace.

events24	
timestamp	TIMESTAMP(6) WITHOUT TIME ZONE
event	CHARACTER VARYING(45)
entity	CHARACTER VARYING(45)
note	TEXT

This table represents the MES event trace of the last 24 hours.

moves_report	
timestamp	TIMESTAMP(6) WITHOUT TIME ZONE
tool	CHARACTER VARYING(45)
toolfam	CHARACTER VARYING(100)
mvs	BIGINT

This table shows the moves per tool.

state_report	
date	TIMESTAMP(6) WITHOUT TIME ZONE
week	INTEGER
tool	CHARACTER VARYING(45)
state	CHARACTER VARYING(45)
cumtime	INTEGER

This table shows entity state statistics.

wip_report	
timestamp	TIMESTAMP(6) WITHOUT TIME ZONE
product	CHARACTER VARYING(32)
state	CHARACTER VARYING(25)
qty	BIGINT

This reports shows the WIP per product and state (ACTIVE, STARTED, FINISHED)

ct_report	
date	TIMESTAMP(6) WITHOUT TIME ZONE
week	INTEGER
product	CHARACTER VARYING(32)
route	CHARACTER VARYING(45)
oper	CHARACTER(4)
tool	CHARACTER VARYING(45)
qtdev	INTEGER
qtavg	INTEGER
qtmin	INTEGER
qtmax	INTEGER
qtsamples	INTEGER
ptdev	INTEGER
ptavg	INTEGER
ptmin	INTEGER
ptmax	INTEGER
ptsamples	INTEGER

This table shows cycle time statistics.

tool_wip_report	
timestamp	TIMESTAMP(6) WITHOUT TIME ZONE
tool	CHARACTER VARYING(45)
toolfam	CHARACTER VARYING(100)
wip	BIGINT

This table shows the WIP per tool.

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Entities Table Purpose

This table lists all entities of the MES. Entities are ressourcen – not material or consumables. It is stored whether the entity is enabled for automated MES operation or not. The current entity state is also stored here.

Table definition

entity – PK	character varying(45) NOT NULL, - the unique entity identifier
class	character varying(45) NOT NULL, - the entity class (e.g. TOOL, MGR)
enabled	integer, - Flag indicating whether the entity is enabled for automated MES operation (1=yes, 0=no)
note	text, - any note on the entity
state	character varying(45) NOT NULL, - the current state (REG = there is currently a MES client registered for operation)

Notes

1)

Tool Table Purpose

The table stores all the tools, the tool family, the tool type, the current state and MTTF, MTTR. This table is important for the tool clients, since their behaviour depends on the given tool type. MTTF and MTTR are used to model tool availability.

Table definition

tool - PK	character varying(45) NOT NULL, - the unique tool identifier – is a reference to an entities.entity
toolfam	character varying(100) NOT NULL, - the name of the related tool family
owner	character varying(45), - the owner of the tool – might be an entity of class = 'PERSON'
tooltype	character varying(45) NOT NULL, - the tool type classifies the tool manufacturing characteristics (e.g. Part, Batch, PartInterval, ...)
mttr	integer NOT NULL, - Mean Time To Repair [hr]
mttf	integer NOT NULL, - Mean Time To Failure [hr]
state	character varying(45) NOT NULL, - the current tool state (IDLE, PROC, DOWN, MAINT, ENG, UKN)

Notes

1)

Lot Table Purpose

This table is used to store lot manufacturing state information. The data changes as the lot moves within the manufacturing system.

Table definition

lotid - PK	character varying(15) NOT NULL, - the unique lot name
priority	integer DEFAULT 0, - a numeric value; max priority = max value
pieces	integer NOT NULL DEFAULT 10, - number of work pieces per lot
state	character varying(45) NOT NULL, - the lot state (WAIT, FINISHED, HOLD, OP_COMP, PROC, ...)
product	character varying(32) NOT NULL, - the product identifier – must match to prodfLOW.product
route	character varying(45) NOT NULL, - the route the lot is currently manufactured at – must match workflow.route
oper	character(4) NOT NULL, - the operation number the lot is currently manufactured at within the route – must match workflow.route and workflow.oper
customer	character varying(45) NOT NULL, - the customer identifier
"ORDER"	character varying(45), - the customer order identifier
duedate	date, - the manufacturing due date for the lot
startdate	date, - the manufactured start date for the lot
enteroper	timestamp without time zone,

- the time the lot did enter the current operation

procstart timestamp without time zone,
- the time the lot processing started at the current operation

disptool character varying(45),
- the tool that is currently processing the lot – must match tool.tool

Notes

1) In the WAIT state, the DISPTOOL and PROCSTART columns must be empty, since this is the criterium for task selecting lots by the dispatch operation.

Prodflow Table Purpose

This table stores the manufacturing flow as a sequence of route names for every product.

Table definition

product - PK character varying(32) NOT NULL,
- the identifier for a product

route - PK character varying(45) NOT NULL,
- the identifier for a manufacturing route

seq integer NOT NULL,
- sequence number of the route within the manufacturing flow of the product

Notes

1)

Workflow Table Purpose

This table provides the sequence of operations within a route. Every route that is defined in the ProdfLOW table must exist in this table.

Operations are labeled mandatory or not. In case of a non-mandatory operation the step percentage value defines the propability of the execution of the operation. Consequently the skip-rate is 100% - step percentage.

Table definition

route - PK character varying(45) NOT NULL,
- the identifier for a manufacturing route – must match a route within prodfLOW.route

oper - PK character(4) NOT NULL,
- the operation number within the route

"DESC" text,
- any description about the operation

mandatory integer DEFAULT 1,
- flag indicating whether the step is mandatory (1). non-mandatory steps (0) can be skipped by chance. The chance for a skip is 100-stepperc.

stepperc real,
- the propability (%) of performing a non-mandatory step
- field is empty for mandatory steps

Notes

1)

PTime Table Purpose

This table provides the processing time information for every operation and every tool that can perform the operation. A tool must be listed in this table in order to perform an operation. If a tool is not listed here it will never do anything.

Table definition

tool - PK	character varying(45) NOT NULL, - the tool identifier
product - PK	character varying(32) NOT NULL, - the product name
route - PK	character varying(45) NOT NULL, - the identifier for a manufacturing route – must match a route within prodflow.route
oper - PK	character(4) NOT NULL, - the operation number within the route
ptime	integer, - the time it takes to process the lot - ptime unit is minutes
interval	integer, - the time it takes until the tool can start processing the next lot - interval unit is minutes
recipe	character varying(200), - the name of a related recipe. The recipe will be used by the Lego tools as task name.
res	character varying, - a string describing the resource related action to be performed at the operation ACT:ID:QTY * ACT: Prod, Cons, Req, Rel ID a product or resource id QTY: the number of pieces e.g.: Cons:A100:2 – consume 2 pieces of A100 Prod:2009MF:1 – produce 1 piece of 2009MF Req:Drill100:1 – claim 1 piece of Drill100 Rel:Drill100:1 – release 1 piece of 2009MF

Notes

Lothold Table Purpose

This table is used to define hold positions for lots within the manufacturing process. The holds are checked whenever a lot is moved by the MES from one operation into the next one. The lot state will change into "HOLD", in case a valid hold condition for the lot is found in this table. The lot will sit in "HOLD" state at the defined operation before is gets manufactured.

Table definition

- lotid - PK** character varying(15) NOT NULL,
- the identifier of the lot to be set on hold – must match lot.lotid or wildcard '!
- route - PK** character varying(45) NOT NULL,
- the route where the lot shall go on hold – must match workflow.route or wildcard '!
- oper - PK** character(4) NOT NULL,
- the operation where the lot shall go on hold – must match workflow.oper or wildcard '!
- active - PK** timestamp without time zone NOT NULL,
- a time at that the lot shall be on hold, in case route and oper are not specified
- requestor** character varying(45),
- an identifier for a entity that requests the hold
- notes** text,
- any comment on the hold – e.g. hold reason
- "timestamp"** timestamp without time zone DEFAULT now(),
- the timestamp of the last record update

Notes

1) The SQL statement to check for a lot hold is defined as follows:

```
SELECT * FROM lothold
WHERE
  (lotid='U1234' OR lotid='.') AND
  ((route='.' and oper='.') OR (route='GT2' and oper='0600')) AND
  active<now();
```

So its is clear that a hold can be defined for a particular lot or for all lots('.'), for a particular step or for all steps (route='.' and oper ='.') and the hold will be active at a certain time or immediately in case the

active time is in the past.

Schedevents Table Purpose

This table is used to schedule events for MES entities. In common cases such events are scheduled maintenance activities or Down-Time for vacation for instance. Whenever a tool can transform a state transition it will check this table for any scheduled event that is due and not yet executed. These events will be copied into the tools event list for execution. The 'Executed' field in the data base will be updated with the current time.

Table Definition

entity - PK	character varying(45) NOT NULL, - identifier of the entity that is affected – must match an entities.entity
event - PK	character varying(45) NOT NULL, - the event that is scheduled coded as follows: GoDOWN: ... schedules a down event GoMAINT: ... schedules a maintenance
due - PK	timestamp without time zone NOT NULL, - the time when the event is due
executed	timestamp without time zone, - the time when the event was executed by the entity
requestor	character varying(45), - an identifier for a entity that requests the event
notes	text, - any note on the event

Notes

1) The SQL statement to check for ascheduled event is defined as follows:

```
SELECT entity, event, due FROM schedevents
WHERE
    entity = 'THK501' AND
    executed is NULL AND
    due < now();
```


Tool dedication Table Purpose

Tool dedication is a concept to force or prevent manufacturing of material at selected tools. This can be defined for individual lots or products or for all material at selected manufacturing steps (route and operation).

Table definition

- lotid - PK** character varying(15) NOT NULL,
- the identifier of a lot that shall be manufactured at a dedicated tool
– must match lot.lotid or '.' in case of all lots
- product - PK** character varying(32) NOT NULL,
- the product identifier in case a certain product shall be manufactured at a dedicated tool
– must match prodflow.product or '.' in case of all products
- route - PK** character varying(45) NOT NULL,
- the name of a manufacturing route where the dedication is set
– must match workflow.route
- oper - PK** character(4) NOT NULL,
- the operation number where the dedication is set
– must match workflow.oper
- forcedtools** text,
- a comma-separated list of tool names that are allowed for the operation or '-' in case of an empty list
- forbiddentools** text,
- a comma-separated list of tool names that are forbidden for the operation or '-' in case of an empty list
- requestor** character varying(45),
- an identifier for a entity that requests the dedication
- notes** text,
- any note on the dedication
- "timestamp"** timestamp without time zone DEFAULT now(),
- the last record update timestamp

Notes

Tool dedication is implemented in the task selection of the tools with help of the following SQL Statement:

```
SELECT lp.lotid, lp.route, lp.oper, lp.tool, d.forcedtools, d.forbiddentools
FROM
(
  SELECT l.lotid, l.route, l.oper, p.tool
  FROM lot l, ptime p
  WHERE l.state = 'WAIT' AND l.disptool IS NULL AND p.tool = 'SNK1001'
  AND p.product = l.product AND p.route = l.route AND p.oper = l.oper
) as lp
LEFT JOIN tooldedication d ON
  lp.route=d.route AND lp.oper=d.oper
  -- Bedingungen zur Aufnahme in die DLIS --
  WHERE
    ((d.lotid=lp.lotid OR d.lotid='.') AND (d.forcedtools is NULL
      strpos(d.forcedtools,lp.tool)>0) AND (d.forbiddentools is NULL
      strpos(d.forbiddentools,lp.tool)=0) )
    OR
    ((d.forcedtools is NULL OR strpos(d.forcedtools,lp.tool)>0) AND
      (d.forbiddentools is NULL OR
      strpos(d.forbiddentools,lp.tool)=0) )
    OR
    (d.lotid!=lp.lotid AND d.lotid!='.')
ORDER BY lp.route, lp.oper, lp.lotid;
```

Clause 1) Lot selection: lot state = WAIT and disptool = NULL joined with PTIME table in order to get the tools that can manufacture the lots on their steps.

Tool dedication is an OR of Clause A OR Clause B or Clause C.

Clause A) matching lotid or wildcard AND
matching forced tools or no forced tools AND
not matching forbiddentools or no forbiddentools

Clause B) matching forced tools or no forced tools AND
not matching forbiddentools or no forbiddentools

Clause C) not matching lotid AND lotid is wildcard

Taskrepo Table Purpose

The task repository is a table to store current task data for tools that are connected to the MES via Standard Tool Interface (STI). The data stored here is valid for the task that is currently manufactured by the related tool. If the tool is not in PROC state then there is no data stored here.

Table definition

- id - PK** character varying(200) NOT NULL,
- the identifier is a unique string that consists of toolID:recipe
- state** character varying(45),
- an optional state information string
- "timestamp"** timestamp without time zone DEFAULT now(),
- the record update timestamp
- json** text,
- a JSON string to describe the current task. It should store the lot ID and its current route and operation.

Notes

Events and Events24 Table Purpose

This table is used as the MES process trace. It is also used to generate various tool or lot statistics as well as to generate some manufacturing performance reports. Every state change of an entity or lot is written into the Events table.

The Events24 table has the same information limited to a horizon of 24 hours in the past.

Table definition

"timestamp" - PK	timestamp without time zone NOT NULL DEFAULT now(), - the event occurrence time
event - PK	character varying(45) NOT NULL, - the event code (e.g. LOT MOVE, EndProc, ->PROC)
entity - PK	character varying(45) NOT NULL, - the entity that is related to the event – should match an entities.entity
note	text, - any additional information related to the event

Notes

The different event or note syntaxes are important for reporting and statistics purposes.

The events24 table is populated by the shell script: `/opt/cinderella/vwpdb/reports/update_events24.sh`

TaskRepo Table Purpose

This table is used as a temporary repository for tasks that are currently performed by the Lego machines.

Table definition

id - PK	character varying(200) NOT NULL, - the task identifier string (e.g. BR1001:red=1 green=2 ... ToolID:Recipe)
state	character varying(45), - a tool or task state information
timestamp	timestamp – default now(), - any time information – e.g. the last update time
json	text, - a json formatted string to store generic data in a key – value structure (e.g. lotid, lotstep)

Notes

1)

Tables related to manufacturing resources

Resources Table Purpose

This table lists all resources of the MES. Resources are consumables or special utilities required to perform an operation. The table provides the resource name and its current stock.

Table definition

resid – PK	character varying NOT NULL - the unique resource identifier
stock	integer, not null - the current resource stock level
minstock	integer, not null, default 1 - the minimum stock level, that will trigger a reorder notification
note	character varying - an additional text note

Notes

1)

Resclaim Table Purpose

This table lists all current claims of resources. Resources are always claimed by lots to perform manufacturing operations.

Table definition

lotid – PK	character varying(15) NOT NULL - the unique lot identifier
res – PK	character varying NOT NULL - the unique resource identifier
qty	the number of resources that are currently claimed by the lot

Notes

1)

WIP_report Table Purpose

This tables stores the WIP values per product in the categories STARTED, ACTIVE, FINISHED.
It is update once every 24 hours.

Table definition

"timestamp" - PK	timestamp without time zone NOT NULL DEFAULT now(), - the time the report was generated
product - PK	character varying(32) NOT NULL, - a product identifier - must match prodflow.product
state - PK	character varying(25) NOT NULL, - the state of the WIP (e.g. ACTIVE, FINISHED, STARTED)
qty	bigint, - the amount of material [pieces]

Notes

Table population is triggered by crontab and performed with help of shell scripts in the /opt/cinderella/vwpdb/reports directory.

```
/opt/cinderella/vwpdb/reports/event_wip_report.sh  
/opt/cinderella/vwpdb/reports/event_wip_report_starts.sh  
/opt/cinderella/vwpdb/reports/event_wip_report_finished.sh
```

Tool_wip_report Table Purpose

This tables stores the WIP values per tool. It is update once every 24 hours.

Table definition

"timestamp" - PK timestamp without time zone NOT NULL DEFAULT now(),
- the time the report was generated

tool - PK character varying(45) NOT NULL,
- the tool identifier – must match entities.entity

toolfam character varying(100) DEFAULT NULL::character varying,
- the tool family name - R E D U N D A N T -

wip bigint DEFAULT (0)::bigint,
- the amount of material [pieces]

Notes

Table population is triggered by crontab and performed with help of shell scripts in the /cinderella/vwpdb/reports directory.

/opt/cinderella/vwpdb/reports/event_tool_wip_report.sh

moves_report Table Purpose

This tables stores the moves values per tool. It is update once every 24 hours.
Every processed workpiece represents one move.

Table Definition

"timestamp" - PK	timestamp without time zone NOT NULL DEFAULT now(), - the time the report was generated
tool - PK	character varying(45) NOT NULL, - the tool identifier – must match entities.entity
toolfam	character varying(100) DEFAULT NULL::character varying, - the tool family name - R E D U N D A N T -
mvs	bigint DEFAULT (0)::bigint, - the amount of performed moves [pieces]

Notes

Table population is triggered by crontab and performed with help of shell scripts in the
/cinderella/vwpdb/reports directory.

/opt/cinderella/vwpdb/reports/event_mvs_report.sh

State report Table Purpose

This tables stores tool state statistics.

Table definition

date	timestamp without time zone NOT NULL , - the time the data is related to
week - PK	integer NOT NULL, - the week of the report record
tool - PK	character varying(45) NOT NULL, - the tool ID
state - PK	character varying(45) NOT NULL, - the state ID (e.g. IDLE)
cumtime	integer, - the cumulated amount of time [s] the tool spent in the state in the related week

Notes

The report is produced by the shell script: `/opt/cinderella/vwpdb/reports/statereport.sh`

CT_report Table Purpose

This tables stores tool related cycle time statistics on product route operation context.

Table definition

date - PK	timestamp without time zone NOT NULL , - the time the data is related to
week	integer, - the week of the report record
product - PK	character varying(32) NOT NULL, - a product identifier - must match prodfLOW.product
route - PK	character varying(45) NOT NULL, - the name of a manufacturing route where the dedication is set – must match workflow.route
oper - PK	character(4) NOT NULL, - the operation number where the dedication is set – must match workflow.oper
tool - PK	character varying(45) NOT NULL, - the tool ID
state - PK	character varying(45) NOT NULL, - the state ID (e.g. IDLE)
qtdev	integer, the queue time standard deviation
qtavg	integer, the average queue time [s]
qtmin	integer, the minimum queue time [s]
qtmax	integer, the maximum queue time [s]
qtsamples	integer, the number of queue time samples for this record
ptdev	integer, the process time standard deviation
ptavg	integer, the average process time [s]
ptmin	integer, the minimum process time [s]
ptmax	integer, the maximum process time [s]
ptsamples	integer, the number of process time samples for this record

Notes The report is produced by the shell script: /opt/cinderella/vwpdb/reports/ptreport.sh