Narrative:

The Really Good Engineers Company is a civil engineering firm that provides a full range of services to its clients. After years of operating a manual system, RGE management has decided to automate their project tracking activity. RGE certified professional engineers have responsibility to oversee a project for a client. Each project has one professional engineer assigned; however, a given professional engineer will typically be responsible for several projects, although some work in an administrative capacity and are not involved directly with client projects. All certified professional engineers are partners at RGE and RGE keeps the following professional engineering license data elements: professional engineer 12-character license number, issuing state, most recent professional certification date, continuing education hours achieved since last certification, date partner status awarded. Each certified professional engineer is assigned a company truck; the database should hold each truck's vehicle identification number, year, make, vehicle description, odometer reading, date of odometer reading, purchase date, purchase price of each truck, and whether it is assigned to a partner.

Each project can include more than one client and many clients contract across numerous projects. The total cost of each project is apportioned to clients according to their percentage share of the project cost. Some projects are done for internal reasons and are not associated with clients. RGE management only wants to store data on clients who have contracted for projects. Projects can occur at multiple site locations (i.e., site), so RGE tracks the progress of each project at each site. RGE also has an inventory of construction equipment (e.g., bulldozer, loader, grader, excavator, telescopic handler, backhoe, tractor scraper, skid-steer loader, dump truck, trencher, paver, skidder, compactor, and roller) that are assigned and located on multiple sites, used across projects, and redistributed across sites as necessary. RGE tracks the hours of usage per project for construction equipment and targets construction equipment with more than 10,000 hours of total usage for replacement. Additionally, RGE tracks construction equipment by category and records vehicle identification number, manufacturer, year, model, purchase date, purchase price, hours used, date of last usage, decommission date, and selling price. Each site requires tracking of associated projects' completions as well as the site identification, plat map identification, address, city, county, state, zip, acreage, GIS coordinates, server URL of current infrastructure blueprints, and type of site (i.e., government, industrial, commercial, or residential).

Each project requires multiple forms of labor for completion. Certified professional engineers at RGE are partners in the group and receive compensation based the percentage completion of a project. Contractors are considered as third-party partners who are paid according to contract agreements based on project completion. Salaried employees perform project work, but their labor is not charged directly to any given project. Salaried employee

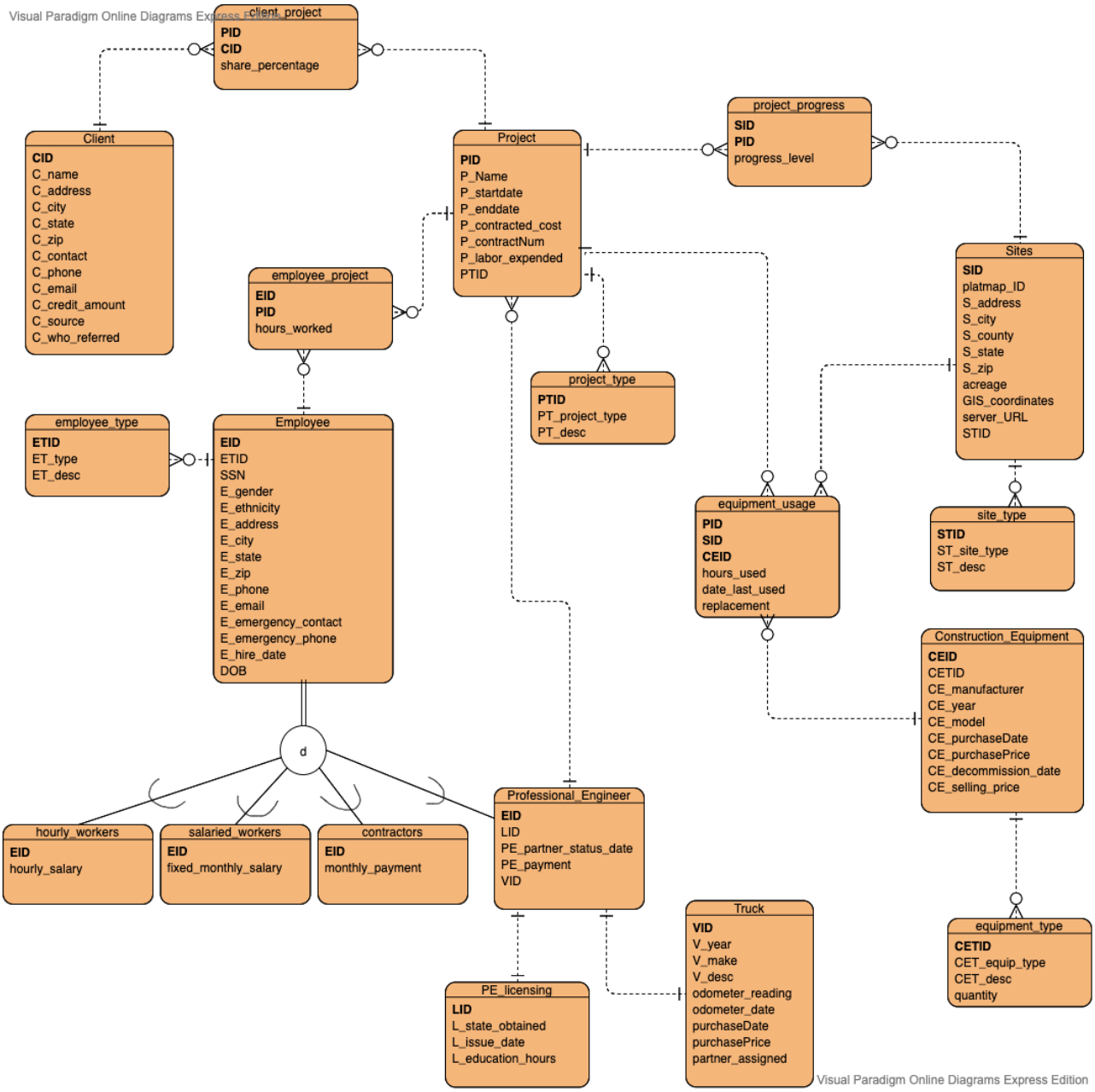
labor is considered a fixed cost. Hourly employee labor is charged directly to projects and is considered a variable cost. Employee types are distinguished by indicators of P for professional engineer, S for staff, H for hourly, and C for contractors. Each professional engineer earns five percent of project cost as the project is completed. Each contractor has a unique contract amount that is paid monthly. Salaried employees are paid monthly based on individual monthly salaries. Hourly employees are paid based on hours worked and their unique hourly wage. Each project tracks the total month-to-date labor charged against the project. A stored procedure is run monthly, outside of this database, that calculates the associated labor charge from labor costs inside this database and then updates the relevant projects' column amounts respectively. RGE also tracks all employees by identification number, social security number or employee identification number, date of birth, gender, ethnicity, address, city, state, zip, cellular phone, preferred email, emergency contact, emergency contact cellular phone, and hire date.

The data on projects includes a project number, name, project description, start date, end date, contracted cost, labor expended, and contract number. Awarded contracts are specific to construction projects and the associated clients. Client data consists of the client's identification number, name, address, city, state, zip, contact, contact phone, contact email, and letter of credit amount. A primary source of new clients is referrals from existing clients; the other source of business comes from RGE advertisements.

RGE has several standing reports and forms that management would like to automate once the new database is completed. RGE tracks which clients refer other new clients. Each day, employees submit forms for hours worked on each project and hours for all construction equipment used. RGE tracks the inventory value of construction equipment by site location, the number of hours of construction equipment usage by individual equipment in each equipment category, as well as the number of hours of construction equipment by category used per project. RGE tracks truck mileage accrued, which trucks are assigned to partners, as well as collecting ending monthly odometer readings from trucks. RGE tracks how many projects are concurrently active on sites, as well as individual project total cost and the percentage of labor cost expended to the total project cost. Finally, RGE also monitors total projects' costs and compares the combined projects' costs across sites for an individual client as a percentage of the letter of credit granted to the clients.

Yellow = Entities
Green = Relationships
Blue = Attributes
Pink = Reports and Forms

ERD


Visual Paradigm Online Diagrams Express Edition
client_project
PID
CID
share_percentage
Client
CID
C_name
C_address
C_city
C_state
C_zip
C_contact
C_phone
C_email
C_credit_amount
C_source
C_who_referred
Project
PID
P_Name
P_startdate
P_enddate
P_contracted_cost
P_contractNum
P_labor_expended
PTID
project_progress
SID
PID
progress_level
employee_project
EID
PID
hours_worked
project_type
PTID
PT_project_type
PT_desc
Sites
SID
platmap_ID
S_address
S_city
S_county
S_state
S_zip
acreage
GIS_coordinates
server_URL
STID
employee_type
ETID
ET_type
ET_desc
Employee
EID
ETID
SSN
E_gender
E_ethnicity
E_address
E_city
E_state
E_zip
E_phone
E_email
E_emergency_contact
E_emergency_phone
E_hire_date
DOB
equipment_usage
PID
SID
CEID
hours_used
date_last_used
replacement
site_type
STID
ST_site_type
ST_desc
Construction_Equipment
CEID
CETID
CE_manufacturer
CE_year
CE_model
CE_purchaseDate
CE_purchasePrice
CE_decommission_date
CE_selling_price
d
hourly_workers
EID
hourly_salary
salaried_workers
EID
fixed_monthly_salary
contractors
EID
monthly_payment
Professional_Engineer
EID
LID
PE_partner_status_date
PE_payment
VID
Truck
VID
V_year
V_make
V_desc
odometer_reading
odometer_date
purchaseDate
purchasePrice
partner_assigned
equipment_type
CETID
CET_equip_type
CET_desc
quantity
PE_licensing
LID
L_state_obtained
L_issue_date
L_education_hours
Visual Paradigm Online Diagrams Express Edition

Logical Model

Project(**PID**, P_name, P_startdate, P_enddate, P_contracted_cost, P_contractNum, P_labor_expended, ***PTID***)

Client(**CID**, C_name, C_address, C_city, C_state, C_zip, C_contact, C_phone, C_email, C_credit_amount, C_source, ***C_who_referred***)

Employee(**EID**, SSN, DOB, E_gender, E_ethnicity, E_address, E_city, E_state, E_zip, E_phone, E_email, E_emergency_contact, E_emergency_phone, E_hire_date, ***ETID***)

Professional_Engineer(**EID**, PE_partner_status_date, PE_payment, ***LID, VID***)

Truck(**VID**, V_year, V_make, V_desc, odometer_reading, odometer_date, purchaseDate, purchasePrice, partner_assigned)

Construction_Equipment(**CEID**, CE_manufacturer, CE_year, CE_model, CE_purchaseDate, CE_purchasePrice, CE_decommission_date, CE_selling_price, ***CETID***)

Sites(**SID**, platmap_ID, S_address, S_city, S_county, S_state, S_zip, acreage, GIS_coordinates, server_URL, ***STID***)

client_project(**PID, CID**, share_percentage)
employee_project(**EID, PID**, hours_worked)
hourly_workers(**EID**, hourly_salary)
salaried_workers(**EID**, fixed_monthly_salary)
contractors(**EID**, monthly_payment)
PE_licensing(**LID**, L_state_obtained, L_issue_date, L_education_hours)

project_progress(**SID, PID**, progress_level)
equipment_usage(**PID, SID, CEID**, hours_used, date_last_used, replacement)

equipment_type(**CETID**, CET_equip_type, CET_desc, quantity)
employee_type(**ETID**, ET_type, ET_desc)
project_type(**PTID**, PT_project_type, PT_desc)
site_type(**STID**, ST_site_type, ST_desc)

DDL Script

```
.echo ON

.mode list

.separator "  |  "

.output Create_RGE_out.txt

.open RGE.DB

PRAGMA foreign_keys = ON;



DROP TABLE IF EXISTS contracts_award;
DROP TABLE IF EXISTS equipment_usage;
DROP TABLE IF EXISTS project_progress;
DROP TABLE IF EXISTS contractors;
DROP TABLE IF EXISTS salaried_workers;
DROP TABLE IF EXISTS hourly_workers;
DROP TABLE IF EXISTS employee_project;
DROP TABLE IF EXISTS client_project;
DROP TABLE IF EXISTS Sites;
DROP TABLE IF EXISTS Construction_Equipment;
DROP TABLE IF EXISTS Professional_Engineer;
DROP TABLE IF EXISTS Employee;
DROP TABLE IF EXISTS Project;
DROP TABLE IF EXISTS Client;
DROP TABLE IF EXISTS Truck;
DROP TABLE IF EXISTS PE_licensing;
DROP TABLE IF EXISTS site_type;
DROP TABLE IF EXISTS project_type;
DROP TABLE IF EXISTS employee_type;
DROP TABLE IF EXISTS equipment_type;


CREATE TABLE equipment_type(
CETID INTEGER CONSTRAINT Equipment_type_CETID_pk PRIMARY KEY,
CET_equip_type VARCHAR(25) NOT NULL CONSTRAINT CET_equip_type_cc
CHECK((CET_equip_type='bulldozer') OR (CET_equip_type='loader') OR
(CET_equip_type='grader') OR (CET_equip_type='telescopic handler') OR
(CET_equip_type='tractor scraper')),
CET_desc VARCHAR(50),
```

```
quantity INTEGER
);

CREATE TABLE employee_type(
ETID INTEGER CONSTRAINT Employee_type_ETID_pk PRIMARY KEY,
ET_type CHAR(1) NOT NULL CONSTRAINT ET_type_cc  CHECK((ET_type='P') OR (ET_type='S') OR
(ET_type='H') OR (ET_type='C')),
ET_desc VARCHAR(50)
);

CREATE TABLE project_type(
PTID INTEGER CONSTRAINT Project_type_PTID_pk PRIMARY KEY,
PT_project_type VARCHAR(25) NOT NULL CONSTRAINT PT_project_type
CHECK((PT_project_type='construction') OR (PT_project_type='other')),
PT_desc VARCHAR(50)
);

CREATE TABLE site_type(
STID INTEGER CONSTRAINT Site_type_STID_pk PRIMARY KEY,
ST_site_type NOT NULL CONSTRAINT ST_site_type_cc  CHECK((ST_site_type='government') OR
(ST_site_type='industrial') OR (ST_site_type='commercial') OR (ST_site_type='residential')),
ST_desc VARCHAR(50)
);

CREATE TABLE PE_licensing(
LID CHAR(12) CONSTRAINT PE_licensing_pk PRIMARY KEY,
L_state_obtained CHAR(2),
L_issue_date DATE,
L_education_hours INTEGER
);

CREATE TABLE Truck(
VID INTEGER CONSTRAINT Truck_VID_pk PRIMARY KEY,
V_year INTEGER NOT NULL,
V_make VARCHAR(25) NOT NULL,
V_desc VARCHAR(50) NOT NULL,
odometer_reading INTEGER,
odometer_date DATETIME,
purchaseDate DATE NOT NULL,
purchasePrice INTEGER NOT NULL,
partner_assigned CHAR(1) NOT NULL, CONSTRAINT partner_assigned_cc
CHECK((partner_assigned='Y') OR (partner_assigned='N'))
);

CREATE TABLE Client(
CID INTEGER CONSTRAINT Client_CID_pk PRIMARY KEY,
```

```
C_name VARCHAR(25) NOT NULL,
C_address VARCHAR(50) NOT NULL,
C_city VARCHAR(25) NOT NULL,
C_state VARCHAR(25) NOT NULL,
C_zip NUMBER(5) NOT NULL,
C_contact VARCHAR(50) NOT NULL,
C_phone NUMBER(10) NOT NULL,
C_email VARCHAR(50) NOT NULL,
C_credit_amount INTEGER NOT NULL,
C_source VARCHAR(50) NOT NULL CONSTRAINT C_source_cc  CHECK((C_source='ad') OR
(C_source='referral')),
C_who_referred VARCHAR(50) CONSTRAINT Client_referral_fk REFERENCES Client(CID)
);

CREATE TABLE Project(

PID INTEGER CONSTRAINT Project_PID_pk PRIMARY KEY,
P_name VARCHAR(25) NOT NULL,
P_startdate DATE,
P_enddate DATE,
P_contracted_cost INTEGER,
P_contractNum INTEGER,
P_labor_expended INTEGER,
PTID INTEGER CONSTRAINT Project_Type_ID_fk REFERENCES project_type(PTID)
);

CREATE TABLE Employee(
EID INTEGER CONSTRAINT Employee_EID_pk PRIMARY KEY,
SSN NUMBER(9) NOT NULL,
DOB DATE NOT NULL,
E_gender CHAR(1) NOT NULL CONSTRAINT E_gender_cc CHECK((E_gender='F') OR
(E_gender='M') OR (E_gender='O')),
E_ethnicity VARCHAR(25) NOT NULL,
E_address VARCHAR(50) NOT NULL,
E_city VARCHAR(25) NOT NULL,
E_state VARCHAR(25) NOT NULL,
E_zip NUMBER(5) NOT NULL,
E_phone NUMBER(10) NOT NULL,
E_email VARCHAR(50) NOT NULL,
E_emergency_contact VARCHAR(50),
E_emergency_phone NUMBER(10),
E_hire_date DATE NOT NULL,
ETID INTEGER CONSTRAINT Employee_Type_ID_fk REFERENCES employee_type(ETID)
);

CREATE TABLE Professional_Engineer(
```

```
EID INTEGER CONSTRAINT EID_Professional_Engineer_pk PRIMARY KEY CONSTRAINT
EID_Professional_Engineer_fk REFERENCES Employee(EID),
PE_partner_status_date DATE,
PE_payment INTEGER NOT NULL,
LID INTEGER CONSTRAINT License_ID_fk REFERENCES PE_licensing(LID),
VID INTEGER CONSTRAINT Vehicle_ID_fk REFERENCES Truck(VID)
);

CREATE TABLE Construction_Equipment(
CEID INTEGER CONSTRAINT Consturction_Equipment_CEID_pk PRIMARY KEY,
CE_manufacturer VARCHAR(25) NOT NULL,
CE_year INTEGER NOT NULL,
CE_model VARCHAR(25) NOT NULL,
CE_purchaseDate DATE NOT NULL,
CE_purchasePrice INTEGER NOT NULL,
CE_decommission_date DATE NOT NULL,
CE_selling_price INTEGER NOT NULL,
CETID CONSTRAINT Construction_equipment_type_ID_fk REFERENCES equipment_type(CETID)
);

CREATE TABLE Sites(
SID INTEGER CONSTRAINT Sites_SID_pk PRIMARY KEY,
platmap_ID CHAR(6) NOT NULL,
S_address VARCHAR(50) NOT NULL,
S_city VARCHAR(25) NOT NULL,
S_county VARCHAR(25) NOT NULL,
S_state VARCHAR(25) NOT NULL,
S_zip NUMBER(5) NOT NULL,
acreage INTEGER NOT NULL,
GIS_coordinates DECIMAL(8,5) NOT NULL,
server_URL VARCHAR(100) NOT NULL,
STID CONSTRAINT Sites_type_ID_fk REFERENCES site_type(STID)
);

CREATE TABLE client_project(
PID INTEGER CONSTRAINT Client_project_PID_fk REFERENCES Project(PID),
CID INTEGER CONSTRAINT Client_project_CID_fk REFERENCES Client(CID),
share_percentage DECIMAL(5,2),
CONSTRAINT Client_project_PID_CID_pk PRIMARY KEY (PID, CID)
);

CREATE TABLE employee_project(
EID INTEGER CONSTRAINT Employee_project_EID_fk REFERENCES Employee(EID),
PID INTEGER CONSTRAINT Employee_project_PID_fk REFERENCES Project(PID),
hours_worked INTEGER
);
```

```
CREATE TABLE hourly_workers(
EID INTEGER CONSTRAINT EID_hourly_workers_pk PRIMARY KEY CONSTRAINT
EID_hourly_workers_fk REFERENCES Employee(EID),
hourly_salary INTEGER NOT NULL
);

CREATE TABLE salaried_workers(
EID INTEGER CONSTRAINT EID_salaried_workers_pk PRIMARY KEY CONSTRAINT
EID_salaried_workers_fk REFERENCES Employee(EID),
fixed_monthly_salary INTEGER NOT NULL
);

CREATE TABLE contractors(
EID INTEGER CONSTRAINT EID_contractors_pk PRIMARY KEY CONSTRAINT EID_contractors_fk
REFERENCES Employee(EID),
monthly_payment INTEGER NOT NULL
);


CREATE TABLE project_progress(
PID INTEGER CONSTRAINT Project_progress_PID_fk REFERENCES Project(PID),
SID INTEGER CONSTRAINT Project_progress_SID_fk REFERENCES Sites(SID),
progress_level DECIMAL(5,2),
CONSTRAINT Project_progress_PID_SID_pk PRIMARY KEY (PID, SID)
);

CREATE TABLE equipment_usage(
PID INTEGER CONSTRAINT Equipment_usage_PID_fk REFERENCES Project(PID),
SID INTEGER CONSTRAINT Equipment_usage_SID_fk REFERENCES Sites(SID),
CEID INTEGER CONSTRAINT Equipment_usage_CEID_fk REFERENCES
Construction_Equipment(CEID),
hours_used INTEGER,
date_last_used DATETIME,
replacement CHAR(1) CONSTRAINT replacement_cc  CHECK(replacement > 10000),
CONSTRAINT Equipment_usage_PID_SID_CETID_pk PRIMARY KEY (PID, SID, CEID)
);


CREATE VIEW contracts_awarded AS
        SELECT DISTINCT client_project.PID, client_project.CID
        FROM client_project, Project, project_type
        WHERE client_project.PID=Project.PID
        AND Project.PTID=project_type.PTID
        AND project_type.PT_desc = 'construction'
        GROUP BY client_project.PID;
```

```
-- CREATE TRIGGER update_labor_cost
--       ON Project AFTER UPDATE
--       AS IF UPDATE(P_labor_charged)
--                BEGIN
--                         DECLARE @P_contracted_cost INTEGER
--                         DECLARE @P_labor_expended INTEGER
--                         DECLARE @P_labor_charged INTEGER
--                         SELECT @P_contracted_cost = (SELECT labor_cost
--                                                                 FROM deleted)
--                         SELECT @P_labor_expended= (SELECT labor_cost
--                                                                 FROM inserted)
--                         SELECT @P_labor_charged= (SELECT P_labor_expended
--                                                                 FROM inserted)
--                         INSERT INTO Project VALUES (@P_contracted_cost, @P_labor_expended,
@P_labor_charged)

--                         END

.output stdout

.echo off
```

Reports/Forms

Client Referral:
Client.CID, Client.C_name, Client.C_address, Client.C_city, Client.C_state, Client.C_zip, Client.C_contact, Client.C_phone, Client.C_email, Client.C_credit_amount, Client.C_source, Client.C_who_referred

Employee Hours:
sum(employee_project.hours_worked) from Employee, Project, employee_project Group by Employee.EID

Employee Construction Usage:
sum(equipment_usage.hours_used) from Employee, Project, equipment_usage, Construction_Equipment Group by Construction_Equipment.CEID, Employee. EID

Construction Inventory:
Sites.S_address, sum(equipment_type.quantity * construction_equipment.selling_price) from Sites, Construction_Equipment, equipment_type Group by Sites.S_address
employee_project.hours_worked Group by Construction_Equipment.CEID
Project.PID, equipment_type.CETID, equipment_type.equip_type

Construction hours used per project:
Project.PID, equipment_type.CETID, construction_equipment.CEID, SUM(equipment_usage.hours_used) Group By Project.PID, equipment_type.CETID

Truck mileage accumulated:
Truck.VID, Truck.V_year, Truck.V_make, Truck.V_desc, Truck.odometer_reading

Trucks assigned to partners:
Truck.VID, Professional_Engineer.EID WHERE Truck.partner_assigned = 'Y'

Projects active on site:
Sites.SID, count(Project.PID)

Individual and total project cost:
Project.PID, Project.P_name, sum(Project.contracted_cost + Project_labor_expended)

Percentage labor cost expended on total project cost:
Project.PID, Project.P_name, (Project_labor_expended / (sum(Project.contracted_cost + Project_labor_expended))*100)

Combined project's cost across individual client from letter of credit percentage:
Client.CID, Sites.SID, Project.PID, client_project.share_percentage, sum(Project.contracted_cost + Project_labor_expended)