

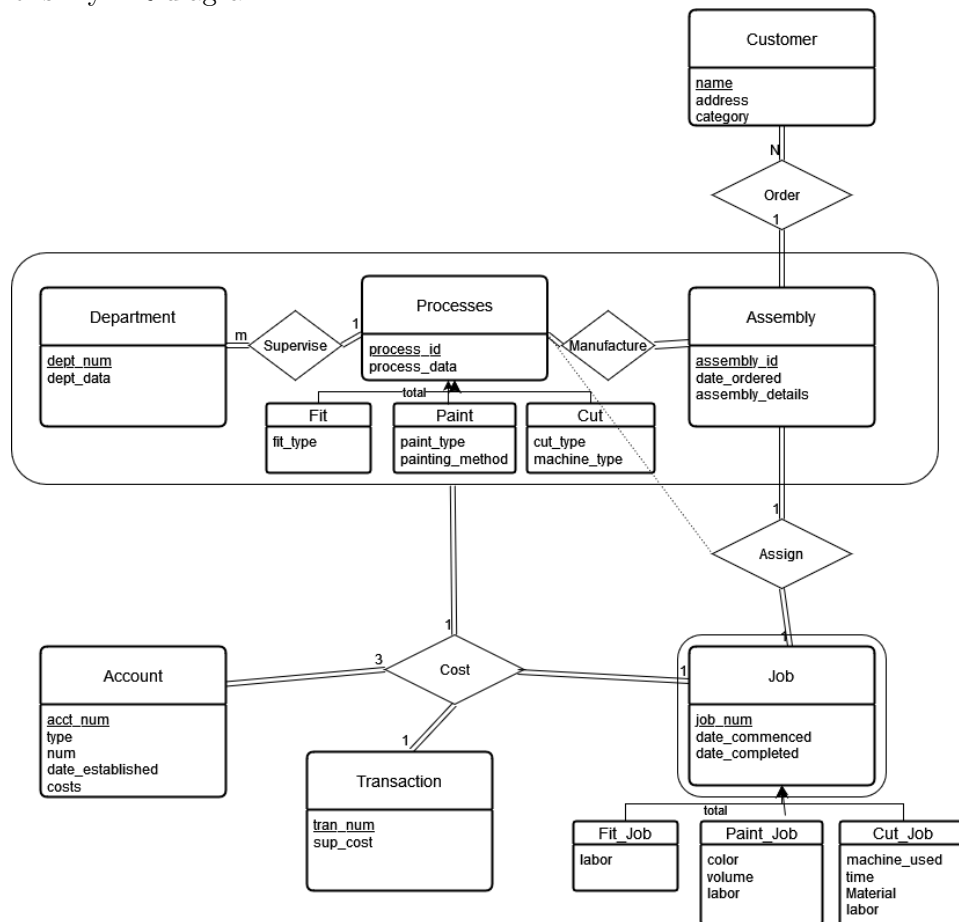
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1 ER Diagram

Here is my ER diagram



2 Relational Database Schema

Here are my schema:

Process(process_id,process_data)
Assemblies(assembly_id,date_ordered, assembly_details)
Manufacture(process_id,assembly_id)
Customer(name,address, category)
Order(name,assembly_id)
Department(dept_num,dept_data)
Supervise(dept_num,process_id)
Fit(process_id, fit_type)
Paint(process_id, paint_type, painting_method)
Cut(process_id,cutting_type, machine_type)
Account(acct_id, type, type_id, date_established, costs)
Job(job_num, job_date.commenced, job_completed)
Assign(job_num, assembly_id,process_id)
Transaction(tran_num, sup_cost)
Costs(job_num, acct_id,process_id, assembly_id, tran_num,dept_num)
Fit_Job(job_num, labor)
Paint_Job(job_num,color,volume, labor)
Cut_Job(job_num, machine_type, time, material, labor)

3 Storage

3.1 Storage Structures

Table Name	Query Number and Type	Search Key	Query Frequency	Selected File Organization	Justification
Customer	1 Insertion	name	30/Day	heap on name	At the moment adding lots of data and not accessing it directly often
Department	2 Insertion	dept_num	infrequent	Sequential on dept_num	Since this data is added infrequently but referenced by other tables often, sequential insertion seems appropriate.
Process (and sub categories)	3 Insertion	process_id, (sub category info)	infrequent	Sequential on process_id (and sub category id)	Infrequent insertion but often called
Supervises	3 Insertion	process_id and dept_num	infrequent	Sequential on process_id	Infrequent insertion but called often on process_id
Orders	4 Insertion	name, assembly_id	40/Day	dynamic hash on name and ass_id	This is a lot of orders to create each day. These will need to be joined with other tables frequently as is happening in our insertion so it is important to be easily accessible
Manufacture	4 Insertion	assembly_id	40/Day (but each assembly may have many processes)	dynamic hash on assembly_id	Frequent insertion with joins on other tables
Account	5 Insertion	type_acct and num 4	10/Day	Multitable clustering with type_acct for clustering and num sequential	This structure will make for fast access later and there is a fair amount of additions here.

Table Name	Query Number and Type	Search Key	Query Frequency	Selected File Organization	Justification
Job	6 Insertion	job_num	50/day	B tree on job_num	B tree is appropriate for often inserted and often called index.
Job	7 Random Search (Insertion of job_date_end)	job_num	50/Day	<i>B</i> tree on job_num	To enter completion data, you'll need a random search on job_num. <i>B</i> tree will be an efficient storage for all these records
Transaction and Costs	8 Random Search	tran_no for Transaction and tran_num, process_id for Costs	50/day	B tree on the tran_no and process_id	We'll need to update a lot of accounts here so it will be important to get to them quickly
Account	9 Random Search	type = Assembly and num	200/day	B tree on num	We have previously done clustering on these attributes so this will require nothing additional to the file
Job	10 Range Search	job_date_completed and job_date_completed	20/day	Sequential index on both dates	Frequent call. If put in order can retrieve data faster
Manufacture	11 Random Search	assembly_id	100/day	Sequential index on assembly_id	This index was already created for Query 4.
Customer	12 Range Search	name (in order) by category	100/Day	Multitable Clustering with category for clustering and name stored in a B^+ tree	Since this data is accessed often this table should be pre-built. New customers are added often so B^+ tree storage on name will be most efficient within this multitable
Cut_Job	13 Range Search	job_num	1/Month	Sequential Index on job_num	Since we are doing a range search, we would like these to be in order.
Paint_Job	14 Random Search	job_num 5	1/Week	Dynamic Hash function on job_num	since we are accessing occasionally but adding lots of jobs, it would be nice to have quick access via a hash.

3.2 Storage Structures on Azure

Info on Azure indexing can be found [here](#). Implementing these was a challenge. Azure uses B trees by default on the primary keys. This is great for random search but not so great for range searches. Since we knew this there were a few indexes that were unnecessary to create. Most of the rest were created especially if there were two attributes that were being indexed together. Sequential indexes (for range sort) were done by adding the ASC or DES tag to the attribute in question. Each index was created and added to the SQL code creating the tables necessary for indexing.

4 SQL and Azure

I have included my entire SQL file here.

```
-- While working on the database design, it's useful to start from scratch every time
-- Hence, we drop tables in reverse order they are created (so the foreign keyconstra
DROP TABLE IF EXISTS Enrollment
DROP TABLE IF EXISTS Student
DROP TABLE IF EXISTS Class
DROP TABLE IF EXISTS Cut_Job;
DROP TABLE IF EXISTS Paint_Job;
DROP TABLE IF EXISTS Fit_Job;
DROP TABLE IF EXISTS Costs;
DROP TABLE IF EXISTS Transact;
DROP TABLE IF EXISTS Assign;
DROP TABLE IF EXISTS Jobs;
DROP TABLE IF EXISTS Maintains;
DROP TABLE IF EXISTS Account;
DROP TABLE IF EXISTS Cut;
DROP TABLE IF EXISTS Paint;
DROP TABLE IF EXISTS Fit;
DROP TABLE IF EXISTS Supervise;
DROP TABLE IF EXISTS Department;
DROP TABLE IF EXISTS Orders;
DROP TABLE IF EXISTS Customer;
DROP TABLE IF EXISTS Manufacture;
DROP TABLE IF EXISTS Assemblies;
DROP TABLE IF EXISTS Processes;
-- Create tables
```



```

CREATE TABLE Processes(
process_id INT PRIMARY KEY,
process_data VARCHAR(64)
);
CREATE TABLE Assemblies(
assembly_id INT PRIMARY KEY,
date_ordered DATE,
assembly_details VARCHAR(64)
);
CREATE TABLE Manufacture (
process_id INT,
assembly_id INT,
CONSTRAINT FK_processid FOREIGN KEY(process_id) REFERENCES Processes,
CONSTRAINT FK_aid FOREIGN KEY(assembly_id) REFERENCES Assemblies
);
CREATE TABLE Customer(
name VARCHAR(64) PRIMARY KEY,
address VARCHAR(64),
category NUMERIC(2,0) NOT NULL,
CHECK(category>0 and category<11)
);
CREATE TABLE Orders (
name VARCHAR(64),
assembly_id INT,
CONSTRAINT PK_orders PRIMARY KEY (name, assembly_id),
CONSTRAINT FK_cname FOREIGN KEY(name) REFERENCES Customer,
CONSTRAINT FK_aidOrders FOREIGN KEY(assembly_id) REFERENCES Assemblies
);
CREATE TABLE Department (
dept_num INT PRIMARY KEY,
dept_data VARCHAR(128)
);
CREATE TABLE Supervise (
dept_num INT,
process_id INT,
CONSTRAINT PK_Supervises PRIMARY KEY(dept_num, process_id),
CONSTRAINT FK_deptnum FOREIGN KEY (dept_num) REFERENCES Department,
CONSTRAINT FK_proccessid FOREIGN KEY (process_id) REFERENCES Processes
);
CREATE TABLE Fit(

```

```

process_id INT PRIMARY KEY,
fit_type VARCHAR(64),
CONSTRAINT FK_fit_process FOREIGN KEY(process_id) REFERENCES Processes
);
CREATE TABLE Paint(
process_id INT PRIMARY KEY,
paint_type VARCHAR(64),
paint_method VARCHAR(64),
CONSTRAINT FK_paint_process FOREIGN KEY(process_id) REFERENCES Processes
);
CREATE TABLE Cut(
process_id INT PRIMARY KEY,
cutting_type VARCHAR(64),
machine_type VARCHAR(64),
CONSTRAINT FK_cut_process FOREIGN KEY(process_id) REFERENCES Processes
);
CREATE TABLE Account(
acct_id INT PRIMARY KEY,
type_acct VARCHAR(10) check (type_acct in ('Process','Assembly','Department')),
date_established DATE,
type_acct_id INT, --I should be a FK to Process, Assembly or department but could not
costs INT
);
/*
CREATE TABLE Maintains(
acct_id INT,
type_acct VARCHAR(10) check (type_acct in ('Process','Assembly','Department')),
--num INT,
CONSTRAINT PK_maintain PRIMARY KEY(acct_id,type_acct),
CONSTRAINT FK_maintain_acct FOREIGN KEY(acct_id) REFERENCES Account--should have FK
);
*/
CREATE TABLE Jobs(
job_num INT PRIMARY KEY,
job_date_commenced DATE,
job_date_completed DATE
);
CREATE TABLE Assign(
job_num INT,
assembly_id INT,

```

```

process_id INT,--this gets the job started but not all of them?
CONSTRAINT PK_assign PRIMARY KEY(job_num,process_id,assembly_id),
CONSTRAINT FK_assign_process FOREIGN KEY(process_id) REFERENCES Processes,
CONSTRAINT FK_assign_job FOREIGN KEY(job_num) REFERENCES Jobs,
CONSTRAINT FK_assign_assembly FOREIGN KEY(assembly_id) REFERENCES Assemblies
);
CREATE TABLE Transact(
tran_num INT PRIMARY KEY,
sup_cost INT
);
CREATE TABLE Costs(--either transact or cost will need a process_id otherwise we won'
job_num INT,
tran_num INT,
process_id INT,
--CONSTRAINT PK_Costs PRIMARY KEY(job_num, tran_num),
CONSTRAINT FK_cost_process FOREIGN KEY(process_id) REFERENCES Processes,
--CONSTRAINT FK_cost_acct FOREIGN KEY(acct_id) REFERENCES Account,
--CONSTRAINT FK_cost_department FOREIGN KEY(dept_num) REFERENCES Department,
--CONSTRAINT FK_cost_assembly FOREIGN KEY(assembly_id) REFERENCES Assemblies,
CONSTRAINT FK_cost_transact FOREIGN KEY(tran_num) REFERENCES Transact,
CONSTRAINT FK_cost_job FOREIGN KEY(job_num) REFERENCES Jobs
);
CREATE TABLE Fit_Job(
job_num INT PRIMARY KEY,
labor NUMERIC(3,0),
CONSTRAINT FK_fit_job FOREIGN KEY(job_num) REFERENCES Jobs
);
CREATE TABLE Paint_Job(
job_num INT PRIMARY KEY,
color VARCHAR(10),
volume NUMERIC(3,2),
labor NUMERIC(3,0),
CONSTRAINT FK_paint_job FOREIGN KEY(job_num) REFERENCES Jobs
);
CREATE TABLE Cut_Job(
job_num INT PRIMARY KEY,
machine_type VARCHAR(10),
time NUMERIC(2,2),
material NUMERIC(2,2),
labor NUMERIC(3,0),

```

```

CONSTRAINT FK_cut_job FOREIGN KEY(job_num) REFERENCES Jobs
);
go
CREATE INDEX customer_name ON Customer(name)--query 1 insertion of customers
GO
CREATE INDEX dept_num ON Department(dept_num ASC) --query 2 insert of departments
GO
CREATE INDEX process ON Processes(process_id ASC) --query 3 making sequential indexes
CREATE INDEX process_cut ON Cut(process_id ASC)
CREATE INDEX process_paint ON Paint(process_id ASC)
CREATE INDEX process_fit ON Fit(process_id ASC)
GO
CREATE INDEX supervies ON Supervise(process_id, dept_num) --query 3 getting the super
GO
CREATE INDEX orders_index ON Orders(name, assembly_id) --query 4 keeping the name and

CREATE INDEX Manufacture_index ON Manufacture(assembly_id)--query4
GO
CREATE INDEX account_index ON Account(type_acct ASC, type_acct_id) --query5 this will
--No need to create 6 and 7 as B tree is created on Primary Key automatically
GO
CREATE INDEX transaction_index ON Transact(tran_num)
CREATE INDEX cost_index ON Costs(tran_num, process_id)--query8
GO
CREATE INDEX account_assembly ON Account(type_acct, type_acct_id)--query9
GO
CREATE INDEX job_date_index ON Jobs(job_date_commenced ASC, job_date_completed ASC)--
GO
--CREATE INDEX manufacture_index ON Manufacture(assembly_id ASC)--query11
CREATE INDEX customer_index ON Customer(name ASC, category)--query 12.  Joining the n
GO
CREATE INDEX cutjob_index ON Cut_Job(job_num)--query 13
GO
CREATE INDEX paintjob_index ON Paint_Job(job_num)--query 14
GO

GO
DROP PROCEDURE IF EXISTS query1 --get rid of the procedure if you built it before

GO

```

```

CREATE PROCEDURE query1 --this is the first.  Need three inputs
    @name VARCHAR(64),
    @address VARCHAR(64),
    @category NUMERIC(2,0)
AS
BEGIN
    INSERT INTO Customer VALUES (@name, @address, @category) --insert me now
END
GO
--EXEC query1 @name = 'Nick', @address = NULL, @category = 10
GO

GO
DROP PROCEDURE IF EXISTS query2 --get rid of the procedure if you built it before

GO
CREATE PROCEDURE query2
    @dept_num INT,
    @dept_data VARCHAR(128)
AS
BEGIN
    INSERT INTO Department VALUES (@dept_num, @dept_data) --insert me now
END
GO
--EXEC query2 @dept_num = 1, @dept_data = NULL
GO
DROP PROCEDURE IF EXISTS query3 --get rid of the procedure if you built it before

GO
CREATE PROCEDURE query3 --this is the first.  Need three inputs
    @process_id INT,
    @process_data VARCHAR(64),
    @type VARCHAR(5),
    @type_type VARCHAR(64),
    @type_method VARCHAR(64)
AS
BEGIN
    INSERT INTO Processes VALUES (@process_id, @process_data) --insert into proce
    IF @type = 'Fit' INSERT INTO Fit VALUES (@process_id, @type_type)
    IF @type = 'Paint' INSERT INTO Paint VALUES (@process_id, @type_type, @type_m

```

```

        IF @type = 'Cut' INSERT INTO Cut VALUES(@process_id, @type_type, @type_method)
END
GO
--EXEC query3 1,'','Fit',NULL,NULL
GO
DROP PROCEDURE IF EXISTS query4 --get rid of the procedure if you built it before

GO
CREATE PROCEDURE query4 --create assembly with all associated processes for customer
    @assembly_id INT,
    @date_ordered DATE,
    @assembly_details VARCHAR(64),
    @name VARCHAR(64),
    @process_ids VARCHAR(64)--take this as a string seperated by commas and we'll split it
AS
BEGIN
    INSERT INTO Assemblies VALUES (@assembly_id, @date_ordered, @assembly_details)
    INSERT INTO Orders VALUES (@name,@assembly_id) --record what customer made the order
    INSERT INTO Manufacture SELECT *,@assembly_id FROM STRING_SPLIT(@process_ids, ',')
END
GO
--EXEC query4 1,'10/01/23',NULL,'Nick','1,1,1'
GO
DROP PROCEDURE IF EXISTS query5 --get rid of the procedure if you built it before

GO
CREATE PROCEDURE query5
    @acct_id INT,
    @type VARCHAR(10),
    @date_established DATE,
    @num INT
AS
BEGIN
    INSERT INTO Account VALUES (@acct_id,@type,@date_established,@num,0) --insert into account
    --INSERT INTO Maintains VALUES (@acct_id,@type)--,@num) --pass this info into maintains
END
GO
--EXEC query5 1,'Process','10/10/20',1

GO

```

```
DROP PROCEDURE IF EXISTS query6 --get rid of the procedure if you built it before
```

```
GO
```

```
CREATE PROCEDURE query6
```

```
    @job_num INT,  
    @job_date_commenced DATE,  
    @assembly_id INT,  
    @process_id INT
```

```
AS
```

```
BEGIN
```

```
    INSERT INTO Jobs (job_num,job_date_commenced) VALUES (@job_num,@job_date_comm
```

```
    INSERT INTO Assign VALUES (@job_num,@assembly_id,@process_id) --pass this inf
```

```
END
```

```
GO
```

```
--EXEC query6 50,NULL,1,1
```

```
GO
```

```
DROP PROCEDURE IF EXISTS query7 --get rid of the procedure if you built it before
```

```
GO
```

```
CREATE PROCEDURE query7
```

```
    @job_num INT,  
    @job_date_completed DATE,  
    @job_type VARCHAR(10),  
    @labor NUMERIC(3,0),  
    @machine_type VARCHAR(10),  
    @time NUMERIC(2,2),  
    @material NUMERIC(2,2),  
    @color VARCHAR(10),  
    @volume NUMERIC(3,2)
```

```
AS
```

```
BEGIN
```

```
    Update Jobs set job_date_completed = @job_date_completed where job_num = @job
```

```
    IF @job_type = 'Fit' INSERT INTO Fit_Job VALUES (@job_num, @labor)
```

```
    IF @job_type = 'Paint' INSERT INTO Paint_Job VALUES (@job_num, @color, @volum
```

```

        IF @job_type = 'Cut' INSERT INTO Cut_Job VALUES(@job_num, @machine_type, @tim
END
GO

--EXEC query7 @job_num = 50, @job_date_completed = '10/01/23', @job_type = 'Fit', @la
GO

GO

DROP PROCEDURE IF EXISTS query9 --get rid of the procedure if you built it before
GO
CREATE PROCEDURE query9
    @assembly_id INT

AS
BEGIN
    Select * FROM Account WHERE type_acct_id = @assembly_id and type_acct = 'Asse
END
GO

GO

DROP PROCEDURE IF EXISTS query12 --get rid of the procedure if you built it before
GO
CREATE PROCEDURE query12
    @category NUMERIC(2,0)

AS
BEGIN
    Select name FROM Customer WHERE category = @category ORDER BY name ASC
END
GO

GO

```



```

DROP PROCEDURE IF EXISTS query13 --get rid of the procedure if you built it before
GO
CREATE PROCEDURE query13
    @job_num_start INT,
    @job_num_end INT

AS
BEGIN
    Delete FROM Jobs Where job_num in (SELECT Jobs.job_num FROM Jobs, Cut_Job Where
    DELETE FROM Cut_Job where (job_num >= @job_num_start) and (job_num<=@job_num_end)
END
GO

EXEC query13 @job_num_start = 50, @job_num_end = 60;

GO

DROP PROCEDURE IF EXISTS query14 --get rid of the procedure if you built it before
GO
CREATE PROCEDURE query14
    @job_num INT,
    @color VARCHAR(10)

AS
BEGIN
    Update Paint_Job set color = @color where job_num = @job_num
END
GO

```

I will also include some screenshots of me utilizing SQL in Azure.

Query 1 ×

▶ Run
□ Cancel query
↓ Save query
↓ Export data as
⌵
⌘ Show only Editor

```

1 EXEC query1 @name = 'Nick', @address = NULL, @category = 10
2
3 SELECT *
4 FROM Customer

```

Results Messages

🔍 Search to filter items...

name	address	category
Nick		10

1.

```

1 EXEC query1 @name = 'John Hamm', @address = '742 Evergreen Terrace', @category = 10
2
3 SELECT *
4 FROM Customer

```

Results Messages

🔍 Search to filter items...

name	address	category
John Hamm	742 Evergreen Terrace	10
Nick		10

```
1 EXEC query1 @name = 'Frank', @address = '701 Fake Street', @category = 1
2
3 SELECT *
4 FROM Customer
```

< Results Messages

🔍 Search to filter items...

name	address	category
Frank	701 Fake Street	1
Gus	701 Fake Street	8
John Hamm	742 Evergreen Terrace	10
Mia Hamm	1112 Fake Street	10
Nick		10

Query 1 ✕

▶ Run ☐ Cancel query ⬇ Save query ⬇ Export data as ▾ 🗺 Show only Editor




```
1 EXEC query2 @dept_num = 1, @dept_data = 'I am a great department'
2
3 SELECT *
4 FROM Department
```

Results Messages

🔍 Search to filter items...

dept_num	dept_data
1	I am a great department

2.

Run ☐ Cancel query  Save query  Export data as  Show only Editor

```
1 EXEC query2 @dept_num = 42, @dept_data = 'Hitchhikers dept'
2
3 SELECT *
4 FROM Department
```

Results Messages

Search to filter items...

dept_num	dept_data
1	I am a great department
2	Weak dept
6	wedgie dept
42	Hitchhikers dept

1 EXEC query3 5, 'process data goes here', 'Fit', 'Fit me well', NULL
2
3 SELECT *
4 FROM Fit

Results Messages

Search to filter items...

process_id	fit_type
1	
3	
5	Fit me well


3.

```

1 EXEC query3 7,'process data goes here','Cut','A cut above the rest','I cut real good'
2
3 SELECT *
4 FROM Processes

```

Results Messages

 Search to filter items...


process_id	process_data
1	process data goes here
3	process data goes here
5	process data goes here
7	process data goes here

```

1 EXEC query3 8,'process data goes here','Cut','A cut above the rest','I cut real good'
2
3 SELECT *
4 FROM Processes
5
6 SELECT *
7 FROM Cut
8

```

Results Messages

 Search to filter items...

process_id	cutting_type	machine_type
7	A cut above the rest	I cut real good
8	A cut above the rest	I cut real good

```

1 EXEC query4 2, '10/01/23', NULL, 'Gus', '1,1,1,7,8'
2
3 SELECT *
4 FROM Manufacture
5

```

Results Messages

1	1
1	1
7	1
8	1
1	1
1	1
1	1
7	1
8	1
1	2
1	2

4. **Query results**

```
1 EXEC query4 3,'10/11/23','Coolest assembly ever','Nick','1,7,8,1'
2
3 SELECT *
4 FROM Manufacture
5
```

Results		Messages
8		1
1		2
1		2
1		2
7		2
8		2
1		3
7		3
8		3
.		-

```
1
2
3 SELECT *
4 FROM Assemblies
5
6
```

Results		Messages
<input type="text" value="Search to filter items..."/>		
assembly_id	date_ordered	assembly_details
1	2023-10-01T00:00:00.0000000	
2	2023-10-01T00:00:00.0000000	
3	2023-10-11T00:00:00.0000000	Coolest assembly ever

```
1
2
3 SELECT *
4 FROM Orders
5
6
```


Results Messages

 Search to filter items...

name	assembly_id
Gus	1
Gus	2
Nick	1
Nick	3

```
1 EXEC query5 2, 'Assembly', '10/11/20', 1
2
3 SELECT *
4 FROM Account
5
6
```

Results Messages

 Search to filter items...

acct_id	type_acct	date_established	type_acct_id	costs
1	Process	2020-10-11T00:00:00.0000000	1	0
2	Assembly	2020-10-11T00:00:00.0000000	1	0
5	Process	2020-10-11T00:00:00.0000000	7	0

5.


```
1 EXEC query5 12,'Department','10/11/20',2
2
3 SELECT *
4 FROM Account
5
6
```

Results Messages

 Search to filter items...

acct_id	type_acct	date_established	type_acct_id	costs
1	Process	2020-10-11T00:00:00.0000000	1	0
2	Assembly	2020-10-11T00:00:00.0000000	1	0
3	Assembly	2020-10-11T00:00:00.0000000	2	0
5	Process	2020-10-11T00:00:00.0000000	7	0
12	Department	2020-10-11T00:00:00.0000000	2	0