KOMPONENTSYSTEM

ELIA RÖNNING - SP20 

MYCKET ATT GÅ IGENOM SÅ SPARA FRÅGORNA TILL SLUTET.

DISCLAIMER!

BEGREPPEN ÄR INTE HUGGNA I STEN OCH KAN VARIERA BEROENDE PÅ VEM DU PRATAR MED. DET FINNS INGET RÄTT ELLER FEL.

VAD ÄR ETT KOMPONENTSYSTEM?

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- Motorarkitektur

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- Composition over Inheritance

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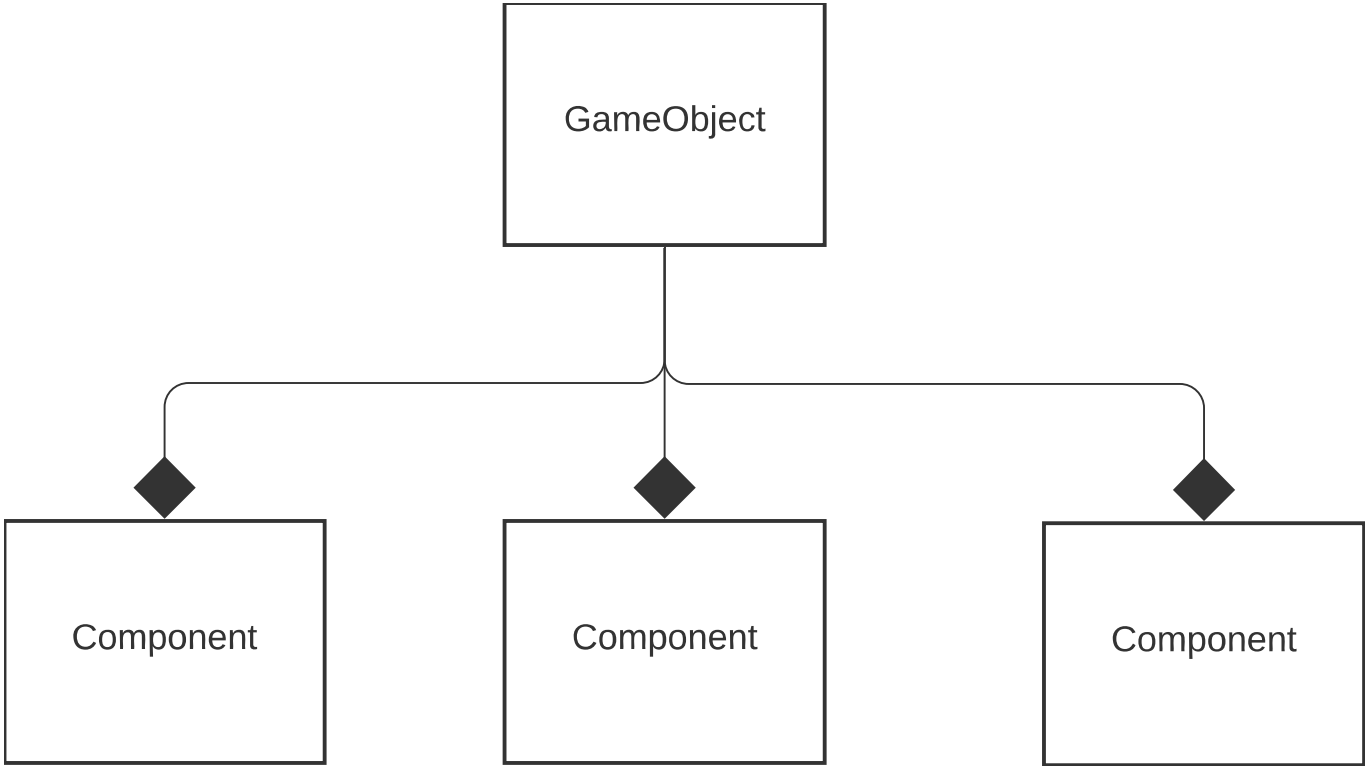
- Motorarkitektur
- Composition over Inheritance
- Dynamisk och generell hantering av objekt i spelvärlden

GAMEOBJECTS HAR KOMPONENTER



COMPOSITION OVER INHERITANCE

```
class PlayerCharacter :
public Transform, public Sprite,
public PhysicsBody, public BoxCollider
{
public:
  PlayerCharacter();
  ~PlayerCharacter();

  void Init();
  void Update(float dt);
  void Render();

  // ...

private:
```

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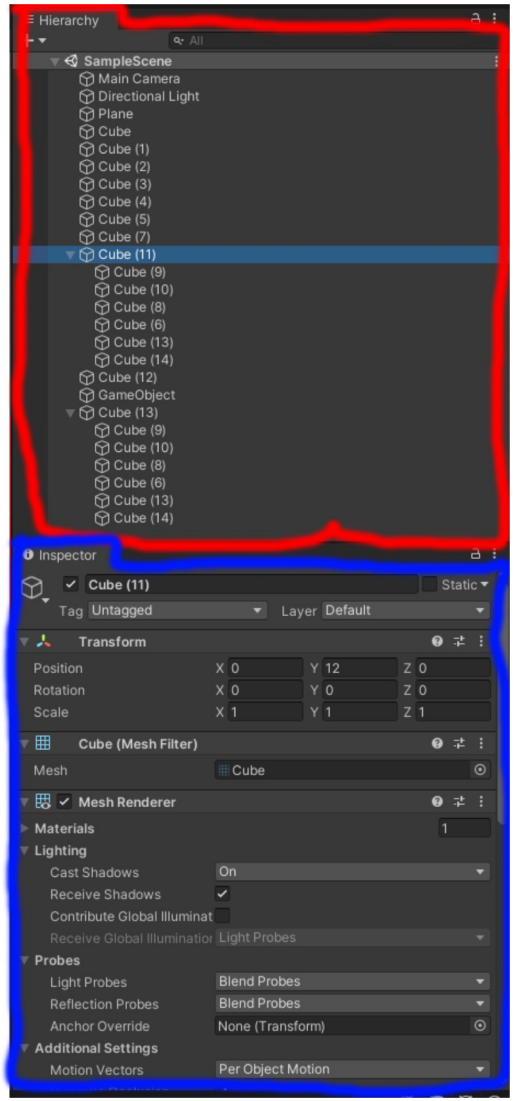
- Kompositionen av ett objekt kan ändras i runtime.
- Gjort för serialisering av objekt.
- GameObjects ska kunna laddas in från exempelvis JSON, istället för att bestämmas vid compile time.

EXEMPEL

GameObjects

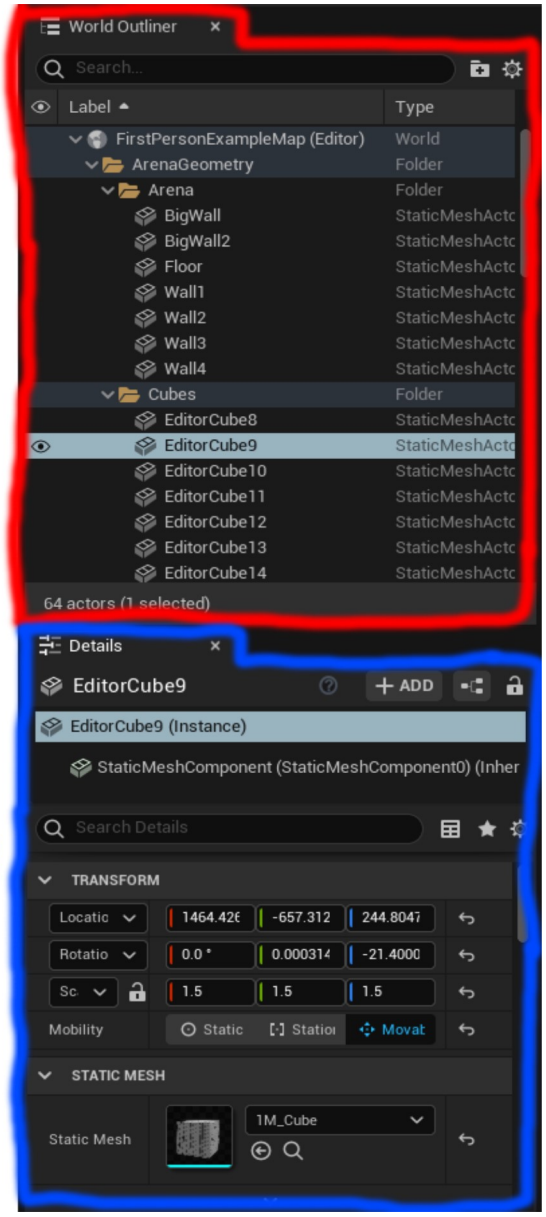
Components



EXEMPEL

Actors

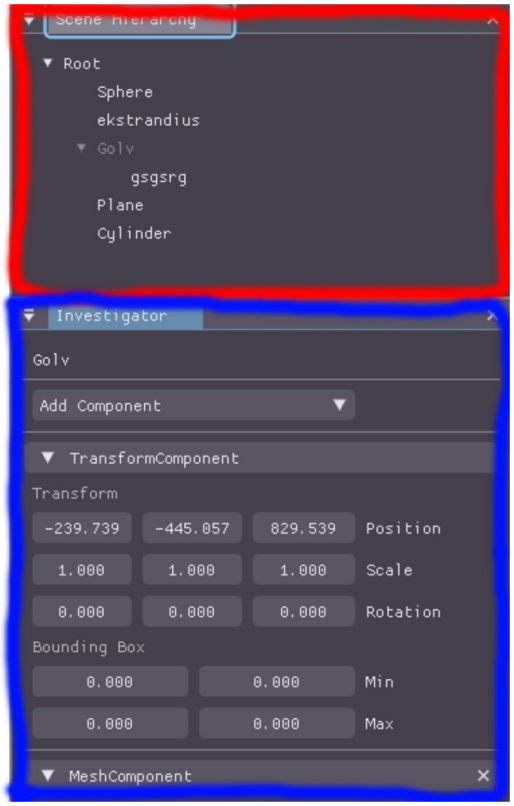
Components



EXEMPEL

Entities

Components



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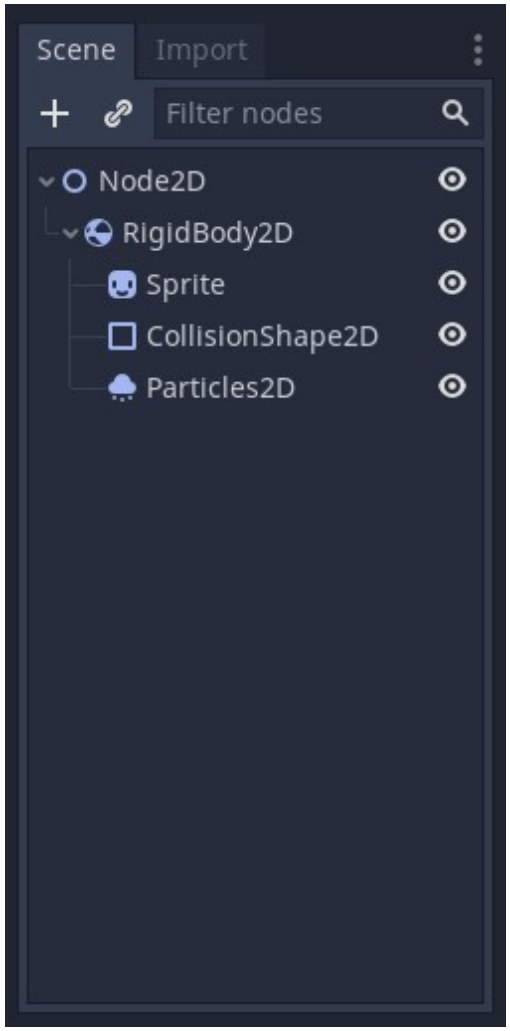
Scene
Import
Filter nodes
Node2D
RigidBody2D
Sprite
CollisionShape2D
Particles2D

VAD ÄR INTE ETT KOMPONENTSYSTEM?

NÅGRA EXEMPEL:

ARV

```
class PlayerCharacter :
public Transform, public Sprite,
public PhysicsBody, public BoxCollider
{
public:
  PlayerCharacter();
  ~PlayerCharacter();

  void Init();
```

KOMPOSITION I COMPILE TIME

```
1  class PlayerCharacter
2  {
3  public:
4    PlayerCharacter();
5    ~PlayerCharacter();
6
7    void Init();
8    void Update(float dt);
9    void Render();
10
11   // ...
12
13 private:
14   Transform myTransform;
15   Sprite mySprite;
```

TYPE OBJECT PATTERN

```
class MonsterEnemy
{
public:
    MonsterEnemy(MonsterType& aTypeObject);

private:
    MonsterType& myType;
};
```

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- ...komponeras objekt i runtime.
- ...sköter komponenterna sig själva.

EXEMPELKOD! 

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- All exempelkod ligger uppe på GitHub och är fungerande.
- Koden är ganska shit och verkligen bare minimum.
- Och igen, det finns inget rätt eller fel, detta är bara ett sätt.

CLASS GAMEOBJECT;

GAMEOBJECT.H

```
1  class GameObject
2  {
3  public:
4    /* Constructors, Destructor, Assignment Operators */
5    GameObject();
6    virtual ~GameObject();
7
8    GameObject(const GameObject& other);
9    GameObject(GameObject&& other) noexcept;
10   GameObject& operator=(const GameObject& other);
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GAMEOBJECT.CPP

```cpp
#include "GameObject.h"

#include "Component.hpp"

std::vector GameObject::ourGameObjects;

GameObject::GameObject()
  : myComponents{}
{
  ourGameObjects.push_back(this);
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GameObject::~GameObject()
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  for (Component* comp : myComponents)
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```

COMPONENT.HPP

```
1  class Component
2  {
3  public:
4      Component() = default;
5      virtual ~Component() = default;
6
7      Component(const Component&) = default;
8      Component(Component&&) = default;
9      Component& operator=(const Component&) = default;
10     Component& operator=(Component&&) = default;
11
12     virtual void Init(class GameObject* parent) = 0;
13     virtual void Update(GameObject* parent, float dt) = 0;
14     virtual void Render(GameObject* parent) = 0;
15 };
```

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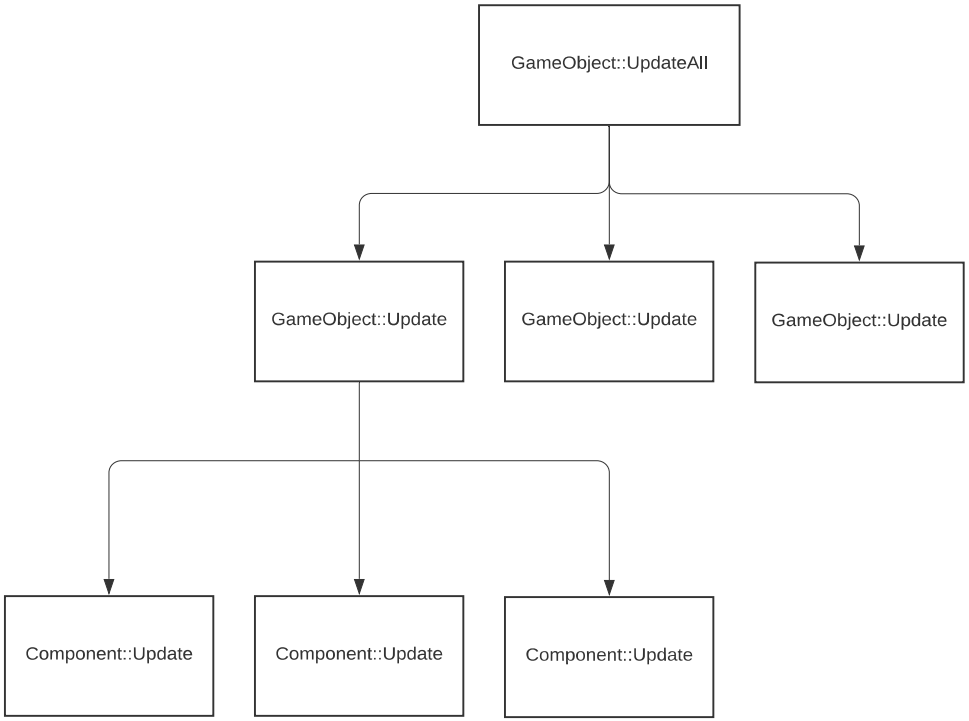
KOMPONENTSYSTEMETS INTERFACE

```
void Init()
{
  GameObject::InitAll();
}

void Update(float dt)
{
  GameObject::UpdateAll();
  GameObject::RenderAll();
              }
```

KOMPONENTSYSTEMETS INTERFACE



EXEMPELKOMPONENT!

SPRITECOMPONENT 😮

SPRITECOMPONENT.H

```
1  class SpriteComponent : public Component
2  {
3  public:
4    /* Constructors, Destructor, Assignment Operators */
5    SpriteComponent();
6    ~SpriteComponent();
7
8    SpriteComponent(const SpriteComponent& sc);
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13   /* Component Virtual Methods */
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SPRITECOMPONENT.CPP

```cpp
#include "SpriteComponent.h"

#include "GameObject.h"

SpriteComponent::SpriteComponent()
  : myTexture(0U)
  , mySize({ 0, 0 })
  , myColor({ 255, 255, 255 })
  , myTexturePath("")
{}

SpriteComponent::~SpriteComponent()
{
  if (myTexture)
  {
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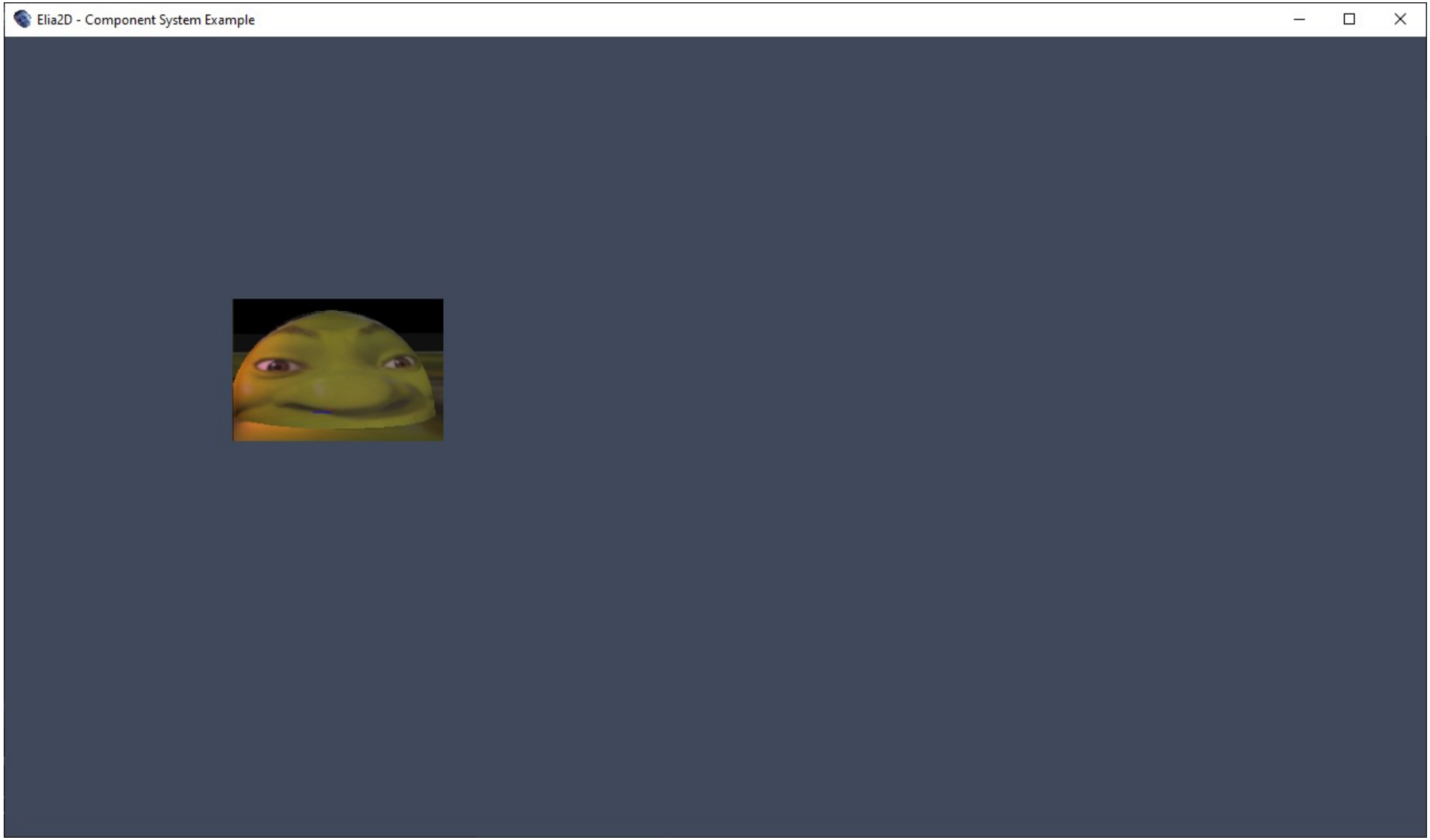
ANVÄNDNINGSEXEMPEL!

SKAPA GAMEOBJECT MED EN SPRITECOMPONENT.

```
GameObject* testObj = nullptr;

void Init()
{
  testObj = new GameObject;
  testObj->SetPosition({ 300, 300 });
  SpriteComponent* spr = testObj->AddComponent<SpriteComponent>()
  spr->SetSpritePath("../Assets/dawdwdawda.png");
}
```

RESULTAT



UPPDATERA GAMEOBJECT

```
1  void Update(float dt)
2  {
3    static float totalTime = 0.0f;
4    totalTime += dt / 2.0f;
5
6    float factor = abs(sinf(totalTime));
7    testObj->SetPosition(
8      { 400.0f + 300.0f * factor, 300.f });
9
10   uint8_t color = uint8_t(factor * 255.0f);
11   testObj->GetComponent()
12     ->SetColor({ color, 0, uint8_t(255 - color) });
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ECS 

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- Men som sagt, begreppen är inte huggna i sten och alla har olika meningar.
- Definition från Designmönster för Spelutveckling.

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- De tre "pelarna" som utgör ett ECS.
- Tänk Model-View-Controller.

CS VS. ECS

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- Komponentsystem - Objektorientering

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- Entity-Component-System - Dataorientering

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- Komponentsystem - Objektorientering
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- (Inte att förväxla med datadriven programmering)

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- Objektorientering: Bunta ihop beteende och data i objekt.
- Dataorientering: Separera data och beteende.
- Array of structs vs. Struct of arrays: Undviker hierarkiska datastrukturer
- Optimerat för CPU-cachen: Hot/Cold splitting.

ARRAY OF STRUCTS VS. STRUCT OF ARRAYS

```
1  class AssociativeArrayOO
2  {
3    struct KeyValuePair
4    {
5      Key k;
6      Value v;
7    };
8    KeyValuePair data[size];
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11 class AssociativeArrayDO
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HOT/COLD SPLITTING

Key	Value	Key	Value	Key	Value	Key	Value

Key	Key	Key	Key	Key	Key	Key	Key
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- **Entity**: Associera komponenter med varandra; ofta bara ett ID.
- **Component**: All data av spelobjekten är atomiserade i komponenter, har inget beteende.
- **System**: Utför beteende på komponenter, har inget eget tillstånd; ofta bara en funktion.

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- Lättare att utföra datatransformationer över flera trådar.
- Mer robust med ID istället pekare.

EXEMPEL: UNITY DOTS

EXEMPELKOD 

ENTITY 

ENTITIES ÄR IDN

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1 #include
2 using Entity = uint32_t;
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- ..men jag körde på en linked list.

ENTITYMANAGER.H

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1  class EntityManager
2  {
3  public:
4    /* Constructors, Destructor, Assignment Operators */
5    EntityManager();
6    ~EntityManager() = default;
7
8    EntityManager(const EntityManager& other);
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INITIALISERA LÄNKADE LISTAN

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1  #include "EntityManager.h"
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3  #include
4
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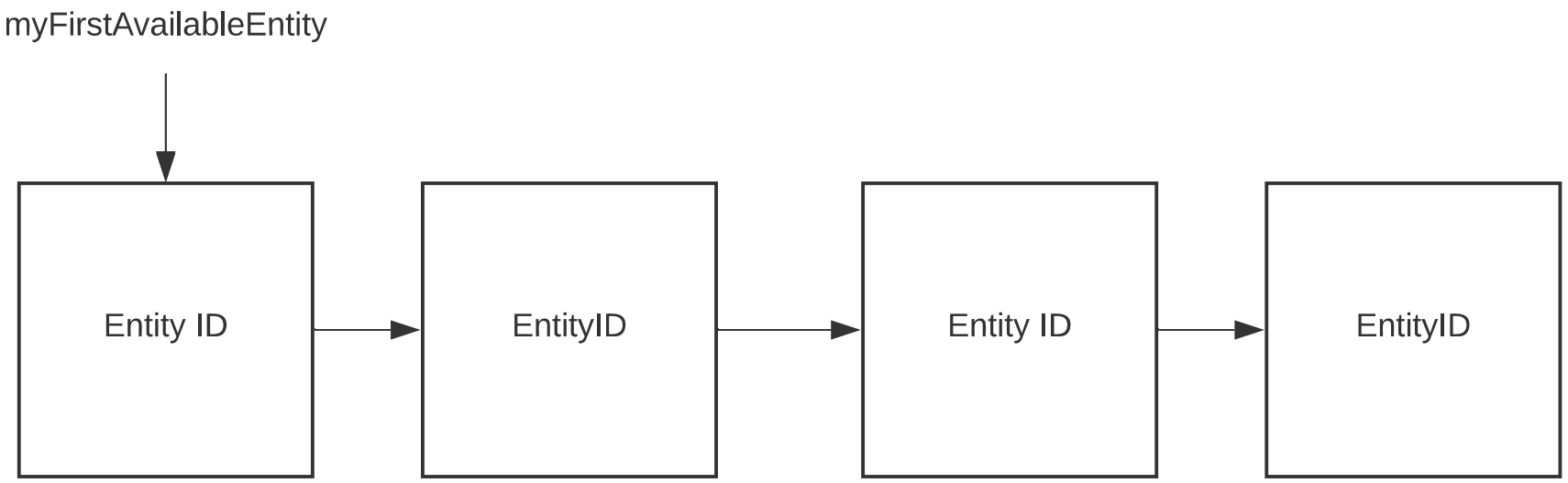
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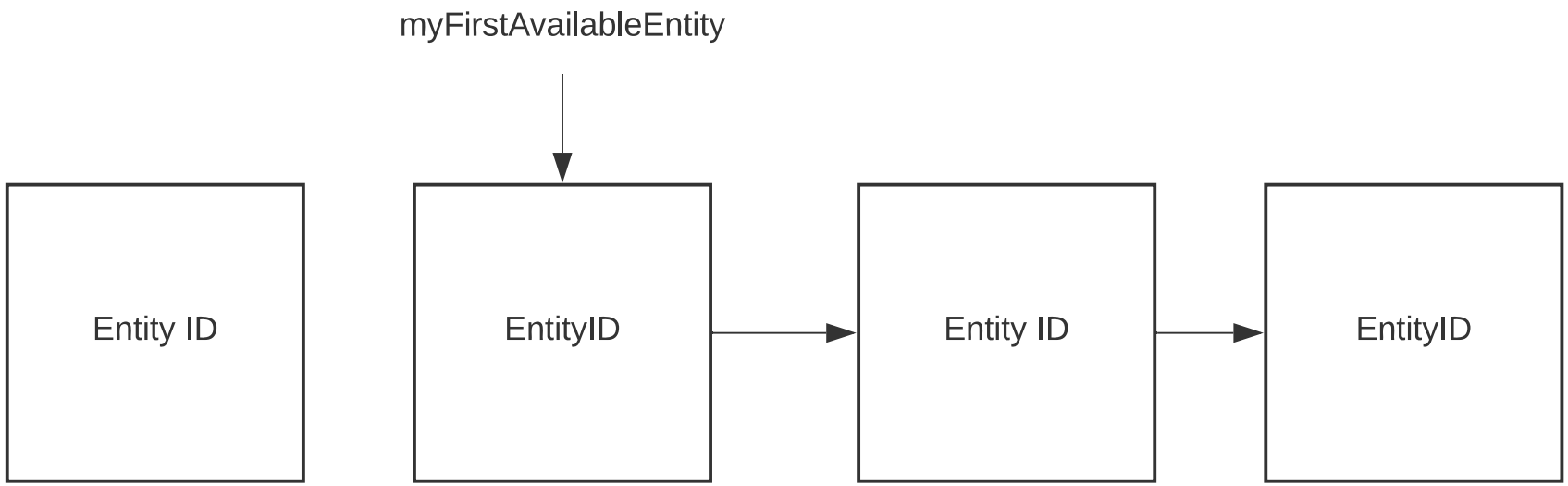
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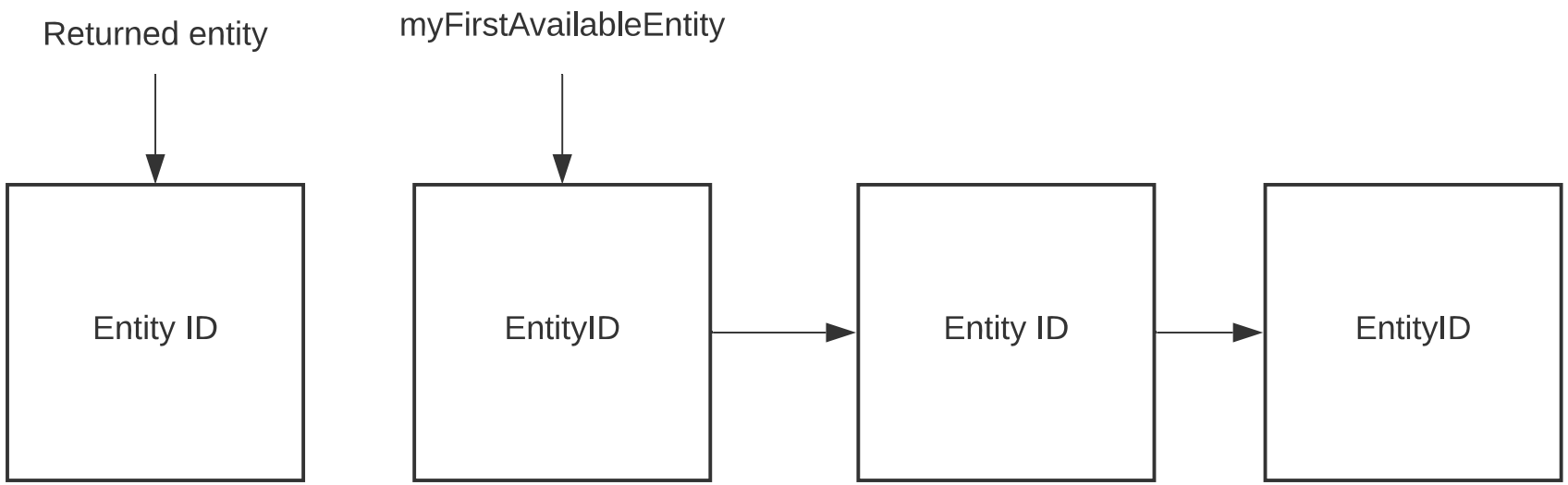

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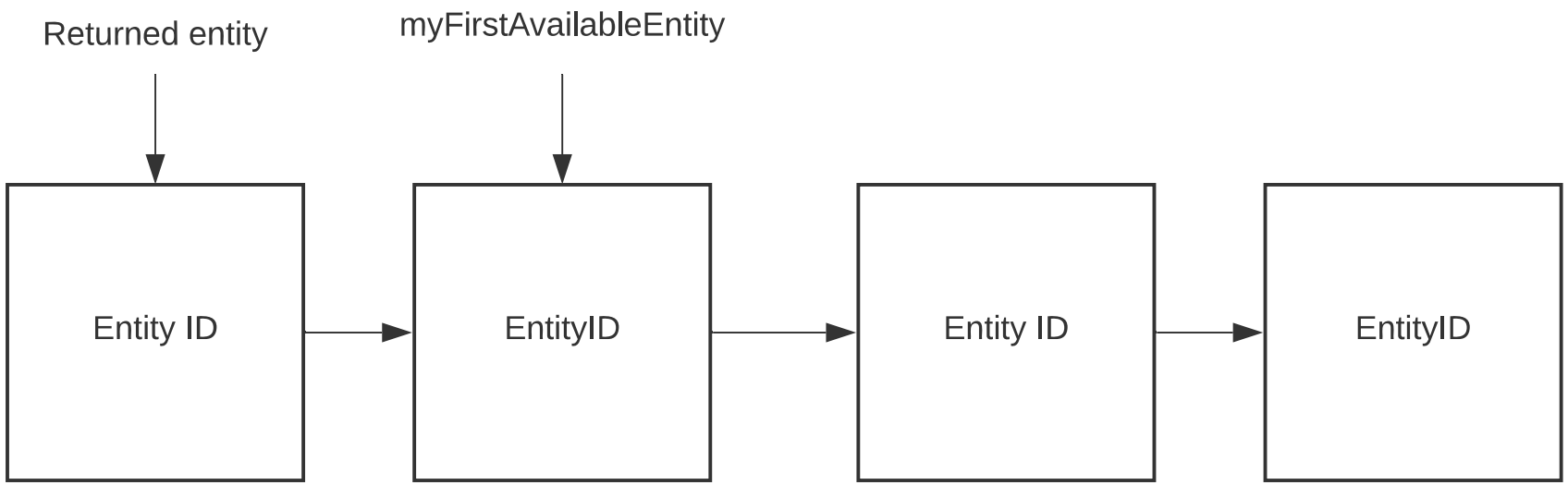

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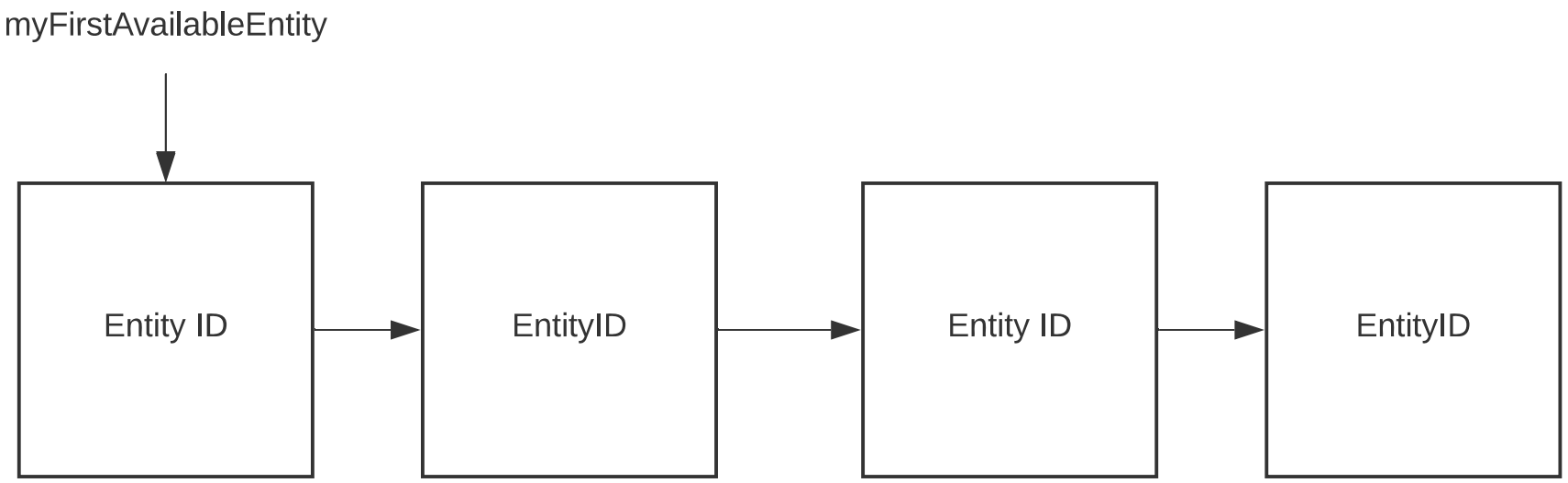

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RESTERANDE FUNKTIONER

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COMPONENT 

COMPONENTARRAY.HPP

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4  public:
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COMPONENTS.HPP

```
1  struct TransformComponent
2  {
3    v2f pos;
4  };
5
6  struct SpriteComponent
7  {
8    Texture myTexture;
9    v2 mySize;
10   Color myColor;
11 };
```

COMPONENTS.HPP

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1  struct TransformComponent
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SYSTEM 

SPRITESYSTEM.H

```
1 namespace Systems
2 {
3   void Sprite(
4     EntityManager* em,
5     ComponentArray* trs,
6     ComponentArray* spr);
7 }
```

SPRITESYSTEM.H

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1 namespace Systems
2 {
3   void Sprite(
4     EntityManager* em,
5     ComponentArray* trs,
6     ComponentArray* spr);
7 }
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SPRITESYSTEM.CPP

```
1  void Sprite(
2    EntityManager* em,
3    ComponentArray* trs,
4    ComponentArray* spr)
5  {
6    TransformComponent* trsList = trs->GetComponents();
7    SpriteComponent* sprList = spr->GetComponents();
8
9    for (Entity e = 0U; e < MAX_ENTITIES; ++e)
10   {
11     if (!em->Validate(e)
12       || !trs->HasComponent(e)
13       || !spr->HasComponent(e))
14       continue;
15
```

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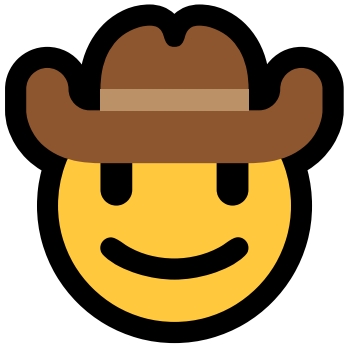
ANVÄNDNINGSEXEMPEL



```
struct GameState
{
  EntityManager entityManager;

  ComponentArray transforms = &entityManager;
  ComponentArray sprites = &entityManager;
} gameState{};

Entity testObj = INVALID_ENTITY;
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void Init()
{
  testObj = gameState.entityManager.GetEntity();

  gameState.transforms.AddComponent(testObj).pos =
    { 300.0f, 300.0f };

  SpriteComponent& sprComp =
    gameState.sprites.AddComponent(testObj);
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```
1  void Update(float dt)
2  {
3    static float totalTime = 0.0f;
4    totalTime += dt / 2.0f;
5    float factor = abs(sinf(totalTime));
6
7    gameState.transforms.GetComponent(testObj).pos =
8      { 400.0f + 300.0f * factor, 300.f };
9
10   uint8_t color = uint8_t(factor * 255.0f);
11   gameState.sprites.GetComponent(testObj).myColor =
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13
14   Systems::Sprite(
15     &gameState.entityManager,
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void Init()
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  testObj = new GameObject;
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  SpriteComponent* spr = testObj->AddComponent<SpriteComponent>
  spr->SetSpritePath("../Assets/dawdwdawda.png");
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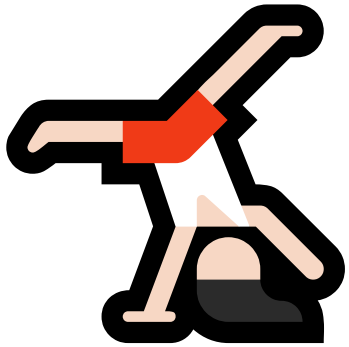
- Det finns många olika lösningar; ingen är one-size-fits-all.

RESURSER



CPPCON 2014: MIKE ACTON "DATA-ORIENTED DESIGN AND C++"

A SIMPLE ENTITY COMPONENT SYSTEM (ECS) [C++] - AUSTIN MORLAN

ENTT

FRÅGOR