FH-OÖ Hagenberg/HSD
SDP3, WS 2025
Übung 2

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Übungsgruppe: 1 — korrigiert:

Beispiel 1 (24 Punkte) Gehaltsberechnung: Entwerfen Sie aus der nachfolgenden Spezifikation ein Klassendiagramm, instanzieren Sie dieses und implementieren Sie die Funktionalität entsprechend:

Eine Firma benötigt eine Software für die Verwaltung ihrer Mitarbeiter. Es wird unterschieden zwischen verschiedenen Arten von Mitarbeitern, für die jeweils das Gehalt unterschiedlich berechnet wird.

Jeder Mitarbeiter hat: einen Vor- und einen Nachnamen, ein Namenskürzel (3 Buchstaben), eine Sozialversicherungsnummer (z.B. 1234020378 -> Geburtsdatum: 2. März 1978) und ein Einstiegsjahr (wann der Mitarbeiter zur Firma gekommen ist).

Bei der Bezahlung wird unterschieden zwischen:

- *CommissionWorker*: Grundgehalt + Fixbetrag pro verkauftem Stück
- *HourlyWorker*: Stundenlohn x gearbeitete Monatsstunden
- *PieceWorker*: Summe erzeugter Stücke x Stückwert
- *Boss*: monatliches Fixgehalt

Überlegen Sie sich, welche Members und Methoden die einzelnen Klassen benötigen, um mindestens folgende Abfragen zu ermöglichen:

- Wie viele Mitarbeiter hat die Firma?
- Wie viele *CommissionWorker* arbeiten in der Firma?
- Wie viele Stück wurden im Monat erzeugt?
- Wie viele Stück wurden im Monat verkauft?
- Wie viele Mitarbeiter sind vor 1970 geboren?

- Wie hoch ist das Monatsgehalt eines Mitarbeiters?
- Gibt es einen Mitarbeiter zu einem gegebenen Namenskürzel?
- Welche(r) Mitarbeiter ist/sind am längsten in der Firma?
- Ausgabe aller Datenblätter der Mitarbeiter

Zur Vereinfachung braucht nur ein Monat berücksichtigt werden (d.h. pro Mitarbeiter nur ein Wert für Stückzahl oder verkaufte Stück). Realisieren Sie die Ausgabe des Datenblattes als *Template Method*. Der Ausdruck hat dabei folgendes Aussehen:

```
****************************************
Fa. Hofer, Linz
****************************************
Datenblatt
---------------
Name: Max Huber
Kürzel: mhu
Sozialversicherungsnummer: 1234010273
Einstiegsjahr: 2005
Mitarbeiterklasse: CommissionWorker
Grundgehalt: 2500 EUR
Provision: 350 EUR
Gesamtgehalt: 2850 EUR
----------------------------------------
v1.0 Oktober 2025
----------------------------------------
```

Achten Sie bei Ihrem Entwurf auf die Einhaltung der Design-Prinzipien!

Schreiben Sie einen Testtreiber, der mehrere Mitarbeiter aus den unterschiedlichen Gruppen anlegt. Die erforderlichen Abfragen werden von einer Klasse `Client` durchgeführt und die Ergebnisse ausgegeben. Achten Sie darauf, dass diese Klasse nicht von Implementierungen abhängig ist.

Treffen Sie für alle unzureichenden Angaben sinnvolle Annahmen und begründen Sie diese. Verfassen Sie weiters eine Systemdokumentation (entsprechend den Vorgaben aus Übung1)!

Allgemeine Hinweise: Legen Sie bei der Erstellung Ihrer Übung großen Wert auf eine **saubere Strukturierung** und auf eine **sorgfältige Ausarbeitung!** Dokumentieren Sie alle Schnittstellen und versehen Sie Ihre Algorithmen an entscheidenden Stellen ausführlich mit Kommentaren! Testen Sie ihre Implementierungen ausführlich! Geben Sie den **Testoutput** mit ab!

Systemdokumentation
Projekt Gehaltsberechnung

Version 1.0

S. Offenberger, S. Vogelhuber

Hagenberg, 22. Oktober 2025

Inhaltsverzeichnis

1 Organisatorisches

1.1 Team

- Simon Offenberger, Matr.-Nr.: S2410306027, E-Mail: Simon.Offenberger@fh-hagenberg.at
- Simon Vogelhuber, Matr.-Nr.: S2410306014, E-Mail: s2410306014@fhooe.at

1.2 Aufteilung der Verantwortlichkeitsbereiche

- Simon Offenberger
  - Design Klassendiagramm
  - Implementierung und Test der Klassen:
    - Company
    - Company Interface
    - Client
  - Implementierung des Testtreibers
  - Dokumentation
- Simon Vogelhuber
  - Design Klassendiagramm
  - Implementierung und Komponententest der Klassen:
    - Employee
    - Boss
    - ComissionWorker

    - PieceWorker
    - HourlyWorker
  - Implementierung des Testtreibers
  - Dokumentation

1.3 Aufwand

- Simon Offenberger: geschätzt 10 Ph / tatsächlich 7 Ph
- Simon Vogelhuber: geschätzt 10 Ph / tatsächlich 8 Ph

2 Anforderungsdefinition (Systemspezifikation)

In diesem Projekt geht es darum die Mitarbeiter eines Unternehmens zu verwalten und deren Gehälter zu berechnen. Es gibt verschiedene Arten von Mitarbeitern, welche unterschiedliche Gehaltsberechnungen haben. Der Zugriff auf die Mitarbeiter soll über eine gemeinsame Schnittstelle erfolgen.

Funktionen der Firmenschnittstelle

- Zugriff auf die wichtigsten Mitarbeiter und Firmendaten

Funktionen der Firma

- Abfage nach der Anzahl der Mitarbeiter.
- Abfage nach der Anzahl eines Mitarbeitertyps in der Firma
- Wie viele Stück wurden im Monat erzeugt?
- Wie viele Stück wurden im Monat verkauft?
- Wie viele Mitarbeiter sind vor einem bestimmten Datum geboren?
- Wie hoch ist das Monatsgehalt eines Mitarbeiters?
- Gibt es einen Mitarbeiter zu einem gegebenen Namenskürzel?
- Welche(r) Mitarbeiter ist/sind am längsten in der Firma?
- Ausgabe aller Datenblätter der Mitarbeiter

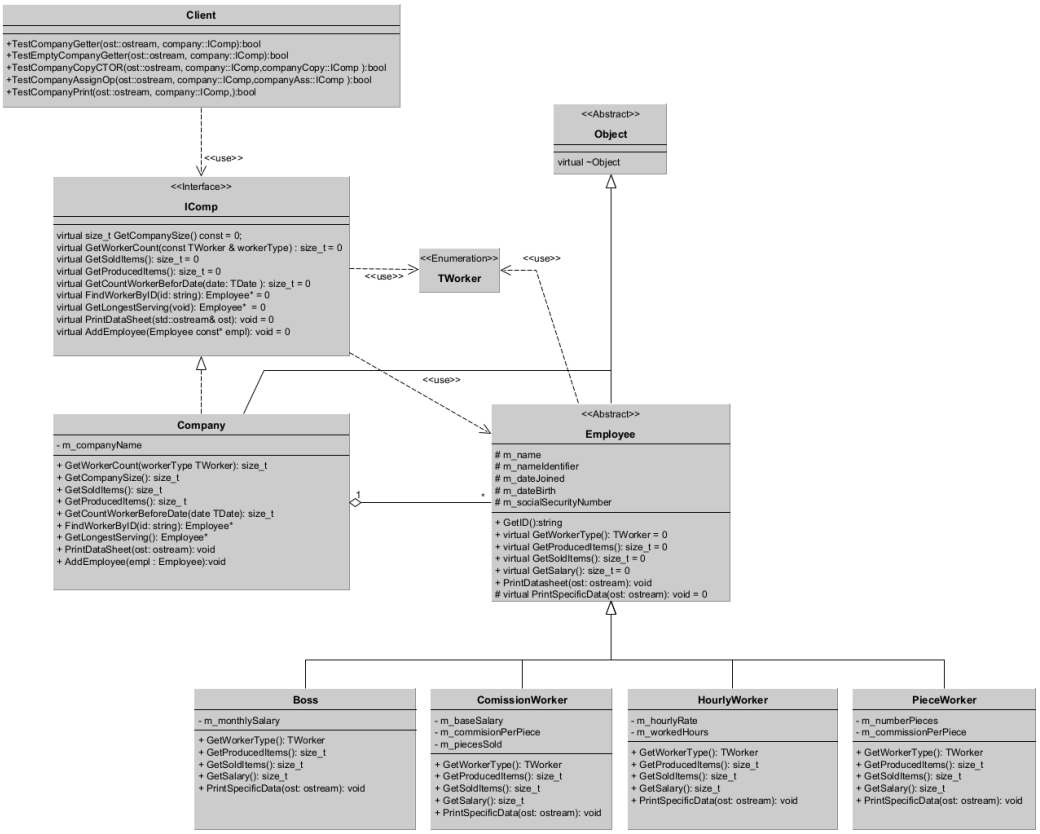
Funktionen der Mitarbeiter

- Speichern von Mitarbeiterdaten.
  - Name
  - Namenskürzel

  - Sozialversicherungsnummer
  - Einstiegsjahr
  - Geburtsjahr
- Berechnung des Gehalts je nach Mitarbeiterklasse.
- Ausgabe von Mitarbeiterinformationen in form eines Datenblatts.

3 Systementwurf

3.1 Klassendiagramm



3.2 Designentscheidungen

Das Interface **ICompany** wurde erstellt, um dem zugreifenden **Client** eine Schnittstelle zur Verfügung zu stellen. Dadurch kann sich der Client auf die Schnittstelle konzentrieren und muss sich nicht um die Implementierungsdetails der Firma kümmern.

Die Firma speichert einen polymorphen Container, der Objekte der abstrakten Klasse **Employee** verwaltet. Bei dem Container wurde eine Map verwendet, da die Mitarbeiter über eine eindeutige ID angesprochen werden können. Somit ist auch das Suchen nach einem Mitarbeiter sehr performant gelöst.

Die Klasse **Employee** ist abstrakt, da es keine generellen Mitarbeiter geben soll, sondern nur spezielle Arten von Mitarbeitern. Die einzelnen Mitarbeiter speichern Daten, die für die Gehaltsberechnung notwendig sind. Die Gehaltsberechnung wird über eine virtuelle Funktion realisiert, die in den abgeleiteten Klassen überschrieben wird. Hier wurde das **Template Methode Pattern** angewandt!

Das Enum mit dem Mitarbeitertypen **TWorker** wurde eingebaut, da die Company den Typen des Mitarbeiters kennen muss, um den Mitarbeiter korrekt zu verwalten. Hierbei wurde aktiv auf RTTI verzichtet, um die Kopplung zwischen Company und den konkreten Klassen die von Employee ableiten zu reduzieren.

4 Dokumentation der Komponenten (Klassen)

Die HTML-Startdatei befindet sich im Verzeichnis ./../doxy/html/index.html

5 Testprotokollierung

```
1
2  ****************************************
3              TESTCASE START
4  ****************************************
5
6  Test Company Get Comission Worker Cnt & Add Empl
7  [Test OK] Result: (Expected: 2 == Result: 2)
8
9  Test Company Get Houerly Worker Cnt & Add Empl
10 [Test OK] Result: (Expected: 1 == Result: 1)
11
12 Test Company Get Boss Cnt & Add Empl
13 [Test OK] Result: (Expected: 1 == Result: 1)
14
15 Test Company Get Piece Worker Cnt & Add Empl
16 [Test OK] Result: (Expected: 2 == Result: 2)
17
18 Test Company FindWorker by ID
19 [Test OK] Result: (Expected: Si1 == Result: Si1)
20
21 Test Company FindWorker by empty ID
22 [Test OK] Result: (Expected: 0000000000000000 == Result:
      ↪ 0000000000000000)
23
24 Test Company Get Size
25 [Test OK] Result: (Expected: 6 == Result: 6)
26
27 Test Company Get Count worker bevor 1930 date
28 [Test OK] Result: (Expected: 0 == Result: 0)
29
30 Test Company Get Count worker bevor 1951 date
31 [Test OK] Result: (Expected: 2 == Result: 2)
32
33 Test Company Get longest serving employee
34 [Test OK] Result: (Expected: 0 == Result: 0)
35
36 Test Company Get total pieces produced
37 [Test OK] Result: (Expected: 50 == Result: 50)
38
39 Test Company Get total pieces sold
40 [Test OK] Result: (Expected: 2700 == Result: 2700)
41
```

```
42
43 ****************************************
44
45
46 ****************************************
47              TESTCASE START
48 ****************************************
49
50 Test Company Copy Ctor
51 [Test OK] Result: (Expected: true == Result: true)
52
53
54 ****************************************
55
56
57 ****************************************
58              TESTCASE START
59 ****************************************
60
61 Test Company Assign Operator
62 [Test OK] Result: (Expected: true == Result: true)
63
64
65 ****************************************
66
67
68 ****************************************
69              TESTCASE START
70 ****************************************
71
72 Test Company Print Exception
73 [Test OK] Result: (Expected: ERROR: Provided Ostream is bad ==
    ↪  Result: ERROR: Provided Ostream is bad)
74
75
76 ****************************************
77
78
79 ****************************************
80              TESTCASE START
81 ****************************************
82
83 Test Empty Company Get Comission Worker Cnt & Add Empl
84 [Test OK] Result: (Expected: 0 == Result: 0)
```

```
85
86  Test Empty Company Get Houerly Worker Cnt & Add Empl
87  [Test OK] Result: (Expected: 0 == Result: 0)
88
89  Test Empty Company Get Boss Cnt & Add Empl
90  [Test OK] Result: (Expected: 0 == Result: 0)
91
92  Test Empty Company Get Piece Worker Cnt & Add Empl
93  [Test OK] Result: (Expected: 0 == Result: 0)
94
95  Test Empty Company FindWorker by ID
96  [Test OK] Result: (Expected: 0000000000000000 == Result:
        ↪ 0000000000000000)
97
98  Test Empty Company FindWorker by ID empty ID
99  [Test OK] Result: (Expected: 0000000000000000 == Result:
        ↪ 0000000000000000)
100
101 Test Empty Company Get Size
102 [Test OK] Result: (Expected: 0 == Result: 0)
103
104 Test Empty Company Get Count worker bevor 1930 date
105 [Test OK] Result: (Expected: 0 == Result: 0)
106
107 Test Empty Company Get Count worker bevor 1951 date
108 [Test OK] Result: (Expected: 0 == Result: 0)
109
110 Test Empty Company Get longest serving employee
111 [Test OK] Result: (Expected: 0000000000000000 == Result:
        ↪ 0000000000000000)
112
113 Test Empty Company Get total pieces produced
114 [Test OK] Result: (Expected: 0 == Result: 0)
115
116 Test Empty Company Get total pieces sold
117 [Test OK] Result: (Expected: 0 == Result: 0)
118
119 Test Company Add nullptr
120 [Test OK] Result: (Expected: ERROR: Passed in Nullptr! ==
        ↪ Result: ERROR: Passed in Nullptr!)
121
122
123 ****************************************
124
```

```
125
126 ****************************************
127              TESTCASE START
128 ****************************************
129
130 Test - Boss.GetSalary()
131 [Test OK] Result: (Expected: 7800 == Result: 7800)
132
133 Test - Boss.GetSoldItems()
134 [Test OK] Result: (Expected: 0 == Result: 0)
135
136 Test - Boss.GetProducedItems()
137 [Test OK] Result: (Expected: 0 == Result: 0)
138
139 Test - Boss.GetWorkerType()
140 [Test OK] Result: (Expected: 0 == Result: 0)
141
142 Test - Boss.GetDateBirth()
143 [Test OK] Result: (Expected: 2000-11-22 == Result: 2000-11-22)
144
145 Test - Boss.GetDateJoined()
146 [Test OK] Result: (Expected: 2022-11-23 == Result: 2022-11-23)
147
148 Test - error buffer
149 [Test OK] Result: (Expected: true == Result: true)
150
151 Test Boss.Clone()
152 [Test OK] Result: (Expected: true == Result: true)
153
154 Test - error buffer
155 [Test OK] Result: (Expected: true == Result: true)
156
157 Boss Constructor bad ID
158 [Test OK] Result: (Expected: ERROR: An employees ID is limited
    ↪  to 3 characters. == Result: ERROR: An employees ID is
    ↪ limited to 3 characters.)
159
160 Boss Constructor bad SV - invalid character
161 [Test OK] Result: (Expected: ERROR: Invalid Sozial Security
    ↪ Number == Result: ERROR: Invalid Sozial Security Number)
162
163 Boss Constructor bad SV - too many nums
164 [Test OK] Result: (Expected: ERROR: Invalid Sozial Security
    ↪ Number == Result: ERROR: Invalid Sozial Security Number)
```

```
165
166
167 ****************************************
168
169
170 ****************************************
171              TESTCASE START
172 ****************************************
173
174 Test - HourlyWorker.GetSalary()
175 [Test OK] Result: (Expected: 3360 == Result: 3360)
176
177 Test - HourlyWorker.GetSoldItems()
178 [Test OK] Result: (Expected: 0 == Result: 0)
179
180 Test - HourlyWorker.GetProducedItems()
181 [Test OK] Result: (Expected: 0 == Result: 0)
182
183 Test - HourlyWorker.GetWorkerType()
184 [Test OK] Result: (Expected: 2 == Result: 2)
185
186 Test - HourlyWorker.GetDateBirth()
187 [Test OK] Result: (Expected: 2000-11-22 == Result: 2000-11-22)
188
189 Test - HourlyWorker.GetDateJoined()
190 [Test OK] Result: (Expected: 2022-11-23 == Result: 2022-11-23)
191
192 Test - error buffer
193 [Test OK] Result: (Expected: true == Result: true)
194
195 Test testPieceWorker.Clone()
196 [Test OK] Result: (Expected: true == Result: true)
197
198 Test - error buffer
199 [Test OK] Result: (Expected: true == Result: true)
200
201 HourlyWorker Constructor bad ID
202 [Test OK] Result: (Expected: ERROR: An employees ID is limited
    ↪  to 3 characters. == Result: ERROR: An employees ID is
    ↪ limited to 3 characters.)
203
204 HourlyWorker Constructor bad SV - invalid character
205 [Test OK] Result: (Expected: ERROR: Invalid Sozial Security
    ↪ Number == Result: ERROR: Invalid Sozial Security Number)
```

```
206
207 HourlyWorker Constructor bad SV - too many nums
208 [Test OK] Result: (Expected: ERROR: Invalid Sozial Security
    ↪ Number == Result: ERROR: Invalid Sozial Security Number)
209
210
211 ****************************************
212
213
214 ****************************************
215             TESTCASE START
216 ****************************************
217
218 Test - PieceWorker.GetSalary()
219 [Test OK] Result: (Expected: 1900 == Result: 1900)
220
221 Test - PieceWorker.GetSoldItems()
222 [Test OK] Result: (Expected: 0 == Result: 0)
223
224 Test - PieceWorker.GetProducedItems()
225 [Test OK] Result: (Expected: 950 == Result: 950)
226
227 Test - PieceWorker.GetWorkerType()
228 [Test OK] Result: (Expected: 3 == Result: 3)
229
230 Test - PieceWorker.GetDateBirth()
231 [Test OK] Result: (Expected: 2000-11-22 == Result: 2000-11-22)
232
233 Test - PieceWorker.GetDateJoined()
234 [Test OK] Result: (Expected: 2022-11-23 == Result: 2022-11-23)
235
236 Test - error buffer
237 [Test OK] Result: (Expected: true == Result: true)
238
239 Test testPieceWorker.Clone()
240 [Test OK] Result: (Expected: true == Result: true)
241
242 Test - error buffer
243 [Test OK] Result: (Expected: true == Result: true)
244
245 PieceWorker Constructor bad ID
246 [Test OK] Result: (Expected: ERROR: An employees ID is limited
    ↪  to 3 characters. == Result: ERROR: An employees ID is
    ↪ limited to 3 characters.)
```

```
247
248 PieceWorker Constructor bad SV - invalid character
249 [Test OK] Result: (Expected: ERROR: Invalid Sozial Security
    ↪ Number == Result: ERROR: Invalid Sozial Security Number)
250
251 PieceWorker Constructor bad SV - too many nums
252 [Test OK] Result: (Expected: ERROR: Invalid Sozial Security
    ↪ Number == Result: ERROR: Invalid Sozial Security Number)
253
254
255 ****************************************
256
257
258 ****************************************
259              TESTCASE START
260 ****************************************
261
262 Test - ComissionWorker.GetSalary()
263 [Test OK] Result: (Expected: 2900 == Result: 2900)
264
265 Test - ComissionWorker.GetSoldItems()
266 [Test OK] Result: (Expected: 300 == Result: 300)
267
268 Test - ComissionWorker.GetProducedItems()
269 [Test OK] Result: (Expected: 0 == Result: 0)
270
271 Test - ComissionWorker.GetWorkerType()
272 [Test OK] Result: (Expected: 1 == Result: 1)
273
274 Test - ComissionWorker.GetDateBirth()
275 [Test OK] Result: (Expected: 2000-11-22 == Result: 2000-11-22)
276
277 Test - ComissionWorker.GetDateJoined()
278 [Test OK] Result: (Expected: 2022-11-23 == Result: 2022-11-23)
279
280 Test - error buffer
281 [Test OK] Result: (Expected: true == Result: true)
282
283 Test testPieceWorker.Clone()
284 [Test OK] Result: (Expected: true == Result: true)
285
286 Test - error buffer
287 [Test OK] Result: (Expected: true == Result: true)
288
```

```
289 ComissionWorker Constructor bad ID
290 [Test OK] Result: (Expected: ERROR: An employees ID is limited
    ↪  to 3 characters. == Result: ERROR: An employees ID is
    ↪ limited to 3 characters.)
291
292 ComissionWorker Constructor bad SV - invalid character
293 [Test OK] Result: (Expected: ERROR: Invalid Sozial Security
    ↪ Number == Result: ERROR: Invalid Sozial Security Number)
294
295 ComissionWorker Constructor bad SV - too many nums
296 [Test OK] Result: (Expected: ERROR: Invalid Sozial Security
    ↪ Number == Result: ERROR: Invalid Sozial Security Number)
297
298
299 ******************************************
300
301
302 ******************************************
303             TESTCASE START
304 ******************************************
305
306 Test Exception in Company Add Duplicate
307 [Test OK] Result: (Expected: ERROR: Duplicate Employee! ==
    ↪ Result: ERROR: Duplicate Employee!)
308
309
310 ******************************************
311
312 TEST OK!!
```

6 Quellcode

6.1 Object.hpp

```
#ifndef OBJECT_HPP
#define OBJECT_HPP

class Object {
public:

        /**
         * \brief Constant for Exception Bad Ostream.
         */
        inline static const std::string ERROR_BAD_OSTREAM = "ERROR: Provided Ostream is bad";

        /**
         * \brief Constant for Exception Fail Write.
         */
        inline static const std::string ERROR_FAIL_WRITE = "ERROR: Fail to write on provided Ostream";

        /**
         * \brief Constant for Exception Nullprt.
         */
        inline static const std::string ERROR_NULLPTR = "ERROR: Passed in Nullptr!";

protected:

        /**
         * \brief protected CTOR -> abstract Object.
         *
         */
        Object() = default;

        /**
         * \brief virtual DTOR -> once Virtual always virtual.
         *
         */
        virtual ~Object() = default;

};

#endif // !OBJECT_HPP
```

6.2 Client.hpp

```
1  /*****************************************************************//**
2   * \file   Client.hpp
3   * \brief  Client Class that uses the Class Company via the Interface IComp
4   *
5   * \author Simon Offenberger
6   * \date   October 2025
7   *********************************************************************/
8  #ifndef CLIENT_HPP
9  #define CLIENT_HPP
10
11 #include <iostream>
12 #include "IComp.hpp"
13
14 class Client {
15 public:
16         /**
17          * Constant for Exception Bad Ostream.
18          */
19         inline static const std::string ERROR_BAD_OSTREAM = "ERROR: Provided Ostream is bad";
20
21         /**
22          * Constant for Exception Write Fail.
23          */
24         inline static const std::string ERROR_FAIL_WRITE = "ERROR: Fail to write on provided Ostream";
25
26         /**
27          * \brief Test Methode for the Getter Methodes of the Company via the Interface.
28          *
29          * \param ost Refernce to an ostream where the Test results should be printed at
30          * \param company Reference to a company interface
31          * \return true -> Test OK
32          * \return false -> Test NOK
33          */
34         bool TestCompanyGetter(std::ostream & ost,IComp& company) const;
35
36         /**
37          * \brief Test Methode for the Getter Methodes of an Empty Company via the Interface.
38          *
39          * \param ost Refernce to an ostream where the Test results should be printed at
40          * \param company Reference to a company interface
41          * \return true -> Test OK
42          * \return false -> Test NOK
43          */
44         bool TestEmptyCompanyGetter(std::ostream & ost,IComp& company) const;
45
46         /**
47          * \brief Test Methode for testing the Copy Ctor of the Company
48          *
49          * \param ost Refernce to an ostream where the Test results should be printed at
50          * \param company Reference to a company interface
51          * \param companyCopy Reference to the copy of company
52          * \return true -> Test OK
53          * \return false -> Test NOK
54          */
55         bool TestCompanyCopyCTOR(std::ostream & ost,const IComp& company,const IComp& companyCopy) const;
56
57         /**
58          * \brief Test Methode for the Assign Operator of Company
59          *
60          * \param ost Refernce to an ostream where the Test results should be printed at
61          * \param company Reference to a company interface
62          * \param companyAss Reference to the assigned Company should be Equal to company
63          * \return true -> Test OK
64          * \return false -> Test NOK
65          */
66         bool TestCompanyAssignOp(std::ostream & ost,const IComp& company,const IComp& companyAss) const;
67
68         /**
69          * \brief Test Methode for the Print Methode of Company
70          *
71          * \param ost Refernce to an ostream where the Test results should be printed at
72          * \param company Reference to a company interface
73          * \return true -> Test OK
```

```
74            * \return false -> Test NOK
75            */
76           bool TestCompanyPrint(std::ostream & ost,const ICOmp& company) const;
77
78   };
79
80   #endif // !CLIENT_HPP
```

6.3 Client.cpp

```cpp
/*****************************************************************//**
 * \file   Client.hpp
 * \brief  Client Class that uses the Class Company via the Interface IComp
 *
 * \author Simon Offenberger
 * \date   October 2025
 *********************************************************************/

#include "Client.hpp"
#include "Test.hpp"
#include "ComissionWorker.hpp"
#include "HourlyWorker.hpp"
#include "Boss.hpp"
#include "PieceWorker.hpp"
#include <sstream>
#include <fstream>

using namespace std;
using namespace std::chrono;

bool Client::TestCompanyGetter(std::ostream& ost, IComp & company) const
{
	if (!ost.good()) throw Client::ERROR_BAD_OSTREAM;

	TestStart(ost);

	bool TestOK = true;
	string error_msg = "";


	try {

		TestOK = TestOK && check_dump(ost, "Test Company Get Comission Worker Cnt & Add Empl",  static_cast<size_t>(2), company.GetWorkerCount(TWorker::E_CommisionWorker));
		TestOK = TestOK && check_dump(ost, "Test Company Get Houerly Worker Cnt & Add Empl",    static_cast<size_t>(1), company.GetWorkerCount(TWorker::E_HourlyWorker));
		TestOK = TestOK && check_dump(ost, "Test Company Get Boss Cnt & Add Empl",                                    static_cast<size_t>(1), company.GetWorkerCount(TWorker::E_Boss));
		TestOK = TestOK && check_dump(ost, "Test Company Get Piece Worker Cnt & Add Empl",             static_cast<size_t>(2), company.GetWorkerCount(TWorker::E_PieceWorker));


		TestOK = TestOK && check_dump(ost, "Test Company FindWorker by ID",                    static_cast<std::string>("Si1"), company.FindWorkerByID("Si1")->GetID());
		TestOK = TestOK && check_dump(ost, "Test Company FindWorker by empty ID",   static_cast<const Employee *>(nullptr), company.FindWorkerByID(""));

		TestOK = TestOK && check_dump(ost, "Test Company Get Size",                                    static_cast<size_t>(6), company.GetCompanySize());

		TestOK = TestOK && check_dump(ost, "Test Company Get Count worker bevor 1930 date", static_cast<size_t>(0), company.GetCountWorkerBeforDate({ 1930y,November,23d }));
		TestOK = TestOK && check_dump(ost, "Test Company Get Count worker bevor 1951 date", static_cast<size_t>(2), company.GetCountWorkerBeforDate({ 1951y,November,23d }));

		TestOK = TestOK && check_dump(ost, "Test Company Get longest serving employee", TWorker::E_Boss, company.GetLongestServing()->GetWorkerType());

		TestOK = TestOK && check_dump(ost, "Test Company Get total pieces produced", static_cast<size_t>(50), company.GetProducedItems());

		TestOK = TestOK && check_dump(ost, "Test Company Get total pieces sold", static_cast<size_t>(2700), company.GetSoldItems());

	}
	catch (const string& err) {
		error_msg = err;
		TestOK = false;
	}
	catch (bad_alloc const& error) {
		error_msg = error.what();
		TestOK = false;
	}
	catch (const exception& err) {
		error_msg = err.what();
		TestOK = false;
	}
	catch (...) {
		error_msg = "Unhandelt Exception";
		TestOK = false;
	}

	TestEnd(ost);

	if (ost.fail()) throw Client::ERROR_FAIL_WRITE;
```

```
74
75          return TestOK;
76  }
77
78  bool Client::TestEmptyCompanyGetter(std::ostream& ost, IComp& company) const
79  {
80          if (!ost.good()) throw Client::ERROR_BAD_OSTREAM;
81
82          TestStart(ost);
83
84          bool TestOK = true;
85          string error_msg = "";
86
87
88          try {
89
90                  TestOK = TestOK && check_dump(ost, "Test␣Empty␣Company␣Get␣Comission␣Worker␣Cnt␣&␣Add␣Empl", static_cast<size_t>(0), company.GetWorkerCount(TWorker::E_CommisionWorker));
91                  TestOK = TestOK && check_dump(ost, "Test␣Empty␣Company␣Get␣Houerly␣Worker␣Cnt␣&␣Add␣Empl", static_cast<size_t>(0), company.GetWorkerCount(TWorker::E_HourlyWorker));
92                  TestOK = TestOK && check_dump(ost, "Test␣Empty␣Company␣Get␣Boss␣Cnt␣&␣Add␣Empl", static_cast<size_t>(0), company.GetWorkerCount(TWorker::E_Boss));
93                  TestOK = TestOK && check_dump(ost, "Test␣Empty␣Company␣Get␣Piece␣Worker␣Cnt␣&␣Add␣Empl", static_cast<size_t>(0), company.GetWorkerCount(TWorker::E_PieceWorker));
94
95
96                  TestOK = TestOK && check_dump(ost, "Test␣Empty␣Company␣FindWorker␣by␣ID", static_cast<const Employee *>(nullptr), company.FindWorkerByID("Si1"));
97                  TestOK = TestOK && check_dump(ost, "Test␣Empty␣Company␣FindWorker␣by␣ID␣empty␣ID", static_cast<const Employee *>(nullptr), company.FindWorkerByID(""));
98
99
100                 TestOK = TestOK && check_dump(ost, "Test␣Empty␣Company␣Get␣Size", static_cast<size_t>(0), company.GetCompanySize());
101
102                 TestOK = TestOK && check_dump(ost, "Test␣Empty␣Company␣Get␣Count␣worker␣bevor␣1930␣date", static_cast<size_t>(0), company.GetCountWorkerBeforDate({ 1930y,November,23d }));
103                 TestOK = TestOK && check_dump(ost, "Test␣Empty␣Company␣Get␣Count␣worker␣bevor␣1951␣date", static_cast<size_t>(0), company.GetCountWorkerBeforDate({ 1951y,November,23d }));
104
105                 TestOK = TestOK && check_dump(ost, "Test␣Empty␣Company␣Get␣longest␣serving␣employee", static_cast<const Employee*>(nullptr), company.GetLongestServing());
106
107
108                 TestOK = TestOK && check_dump(ost, "Test␣Empty␣Company␣Get␣total␣pieces␣produced", static_cast<size_t>(0), company.GetProducedItems());
109
110                 TestOK = TestOK && check_dump(ost, "Test␣Empty␣Company␣Get␣total␣pieces␣sold", static_cast<size_t>(0), company.GetSoldItems());
111
112         }
113         catch (const string& err) {
114                 error_msg = err;
115                 TestOK = false;
116         }
117         catch (bad_alloc const& error) {
118                 error_msg = error.what();
119                 TestOK = false;
120         }
121         catch (const exception& err) {
122                 error_msg = err.what();
123                 TestOK = false;
124         }
125         catch (...) {
126                 error_msg = "Unhandelt␣Exception";
127                 TestOK = false;
128         }
129
130         try {
131
132                 company.AddEmployee(nullptr);
133         }
134         catch (const string& err) {
135                 error_msg = err;
136         }
137         catch (bad_alloc const& error) {
138                 error_msg = error.what();
139         }
140         catch (const exception& err) {
141                 error_msg = err.what();
142         }
143         catch (...) {
144                 error_msg = "Unhandelt␣Exception";
145         }
146
147
148         TestOK = TestOK && check_dump(ost, "Test␣Company␣Add␣nullptr", Object::ERROR_NULLPTR, error_msg);
149
```

```
150         TestEnd(ost);
151
152         if (ost.fail()) throw Client::ERROR_FAIL_WRITE;
153
154         return TestOK;
155 }
156
157 bool Client::TestCompanyCopyCTOR(std::ostream& ost,const IComp& company,const IComp& companyCopy) const
158 {
159
160         if (!ost.good()) throw Client::ERROR_BAD_OSTREAM;
161
162         TestStart(ost);
163
164         bool TestOK = true;
165         string error_msg = "";
166
167         try {
168
169                 stringstream result;
170                 stringstream expected;
171
172                 company.PrintDataSheet(expected);
173                 companyCopy.PrintDataSheet(result);
174
175                 TestOK = TestOK && check_dump(ost, "Test␣Company␣Copy␣Ctor", true ,expected.str() == result.str());
176
177         }
178         catch (const string& err) {
179                 error_msg = err;
180                 TestOK = false;
181         }
182         catch (bad_alloc const& error) {
183                 error_msg = error.what();
184                 TestOK = false;
185         }
186         catch (const exception& err) {
187                 error_msg = err.what();
188                 TestOK = false;
189         }
190         catch (...) {
191                 error_msg = "Unhandelt␣Exception";
192                 TestOK = false;
193         }
194
195         TestEnd(ost);
196
197         if (ost.fail()) throw Client::ERROR_FAIL_WRITE;
198
199         return TestOK;
200
201         return false;
202 }
203
204 bool Client::TestCompanyAssignOp(std::ostream& ost,const IComp& company,const IComp& companyAss) const
205 {
206         if (!ost.good()) throw Client::ERROR_BAD_OSTREAM;
207
208         TestStart(ost);
209
210         bool TestOK = true;
211         string error_msg = "";
212
213         try {
214
215                 stringstream result;
216                 stringstream expected;
217
218                 company.PrintDataSheet(expected);
219                 companyAss.PrintDataSheet(result);
220
221                 TestOK = TestOK && check_dump(ost, "Test␣Company␣Assign␣Operator", true, expected.str() == result.str());
222
223         }
224         catch (const string& err) {
225                 error_msg = err;
```

```
226                 TestOK = false;
227         }
228         catch (bad_alloc const& error) {
229                 error_msg = error.what();
230                 TestOK = false;
231         }
232         catch (const exception& err) {
233                 error_msg = err.what();
234                 TestOK = false;
235         }
236         catch (...) {
237                 error_msg = "Unhandelt Exception";
238                 TestOK = false;
239         }
240
241         TestEnd(ost);
242
243         if (ost.fail()) throw Client::ERROR_FAIL_WRITE;
244
245         return TestOK;
246
247         return false;
248 }
249
250 bool Client::TestCompanyPrint(std::ostream& ost, const IComp& company) const
251 {
252         if (!ost.good()) throw Client::ERROR_BAD_OSTREAM;
253
254         TestStart(ost);
255
256         bool TestOK = true;
257         string error_msg = "";
258
259         fstream badstream;
260         badstream.setstate(ios::badbit);
261
262         try {
263
264                 company.PrintDataSheet(badstream);
265
266         }
267         catch (const string& err) {
268                 error_msg = err;
269         }
270         catch (bad_alloc const& error) {
271                 error_msg = error.what();
272         }
273         catch (const exception& err) {
274                 error_msg = err.what();
275         }
276         catch (...) {
277                 error_msg = "Unhandelt Exception";
278         }
279
280         TestOK = TestOK && check_dump(ost, "Test Company Print Exception", Client::ERROR_BAD_OSTREAM, error_msg);
281
282         TestEnd(ost);
283
284         if (ost.fail()) throw Client::ERROR_FAIL_WRITE;
285
286         return TestOK;
287
288         return false;
289 }
```

6.4 IComp.hpp

```
/*****************************************************************//**
 * \file   IComp.hpp
 * \brief  Interface which is implemented by the company and used by the client
 *
 * \author Simon Offenberger
 * \date   October 2025
 *********************************************************************/
#ifndef ICOMP_HPP
#define ICOMP_HPP

#include <string>
#include "TWorker.hpp"
#include "Employee.hpp"

class IComp{
public:

        /**
         * \brief Gets the current size of the company.
         *
         * \return Size of the company
         */
        virtual size_t GetCompanySize() const = 0;

        /**
         * \brief Get the Count of a specific Worker Type.
         *
         * \param workerType Worker Type from which the count should be determined
         * \return Count of the Worker Type in the Company
         */
        virtual size_t GetWorkerCount(const TWorker & workerType) const = 0;

        /**
         * \brief Get the amount of Sold Items in the whole company.
         *
         * \return Amout of Sold Items
         */
        virtual size_t GetSoldItems() const = 0;

        /**
         * \brief Get the amount of produced items.
         *
         * \return Amout of produced Items
         */
        virtual size_t GetProducedItems() const = 0;

        /**
         * \brief Get the of worker with birth date bevor date.
         *
         * \param date to get the employees which are older
         * \return Amout of employees which are older than the passed in birthdate
         */
        virtual size_t GetCountWorkerBeforDate(const TDate & date) const = 0;

        /**
         * \brief Find a worker with a specific ID.
         *
         * \param id ID for which should be searched for
         * \return nullptr if no Empl is found
         * \return Pointer to Employee
         */
        virtual Employee const * FindWorkerByID(const std::string & id) const = 0;

        /**
         * \brief Get the Employee which has been the longest serving.
         *
         * \return nullptr if company is empty
         * \return Pointer to Employee
         */
        virtual Employee const * GetLongestServing(void) const = 0;

        /**
         * \brief Prints a Datasheet for each employee.
```

```
74            *
75            * \param ost ostream where the Datasheet should be printed at
76            * \return referenced ostream
77            */
78           virtual std::ostream& PrintDataSheet(std::ostream& ost) const = 0;
79
80           /**
81            * \brief Adds am Employee to the Company
82            * \brief The company now owns the Employee and is responsible for destructing of Employee.
83            *
84            * \param empl Employee that should be added to the Company
85            * \throw ERROR_DUPLICATE_EMPL if ID of Employee is already in the collection
86            * \throw ERROR_NULLPTR if an Nullptr is passed in
87            */
88           virtual void AddEmployee(Employee const* empl) = 0;
89
90           /**
91            * \brief Virtual Dtor of Icomp.
92            *
93            */
94           virtual ~IComp() = default;
95   };
96
97   #endif // !ICOMP_HPP
```

6.5 Company.hpp

```
/*****************************************************************//**
 * \file   Company.hpp
 * \brief  Company that holds Employees and provides information about the
 * \brief  Employees of the company.
 *
 * \author Simon Offenberger
 * \date   October 2025
 *********************************************************************/
#ifndef COMPANY_HPP
#define COMPANY_HPP

#include <map>
#include <string>
#include "Object.hpp"
#include "IComp.hpp"

/**
 * Declaration of an alias for the used Container.
 */
using  TContEmployee = std::map<const std::string,Employee const *>;

class Company : public Object, public IComp{
public:
        /**
         * Constant for the Excetion of an Duplicate Employee.
         */
        inline static const std::string ERROR_DUPLICATE_EMPL = "ERROR: Duplicate Employee!";

        /**
         * \brief CTOR for a Company.
         *
         * \param name Name of the Company
         */
        Company(std::string name) : m_companyName{ name } {}

        /**
         * \brief Copy Ctor of the Company.
         *
         * \param comp Refernce to the company that should be copied
         */
        Company(const Company & comp);

        /**
         * \brief Assignoperator for a company uses Copy and Swap.
         *
         * \param comp Copy of the company
         */
        void operator=(Company comp);

        /**
         * \brief Adds am Employee to the Company
         * \brief The company now owns the Employee and is responsible for destructing of Employee.
         *
         * \param empl Employee that should be added to the Company
         * \throw ERROR_DUPLICATE_EMPL if ID of Employee is already in the collection
         * \throw ERROR_NULLPTR if an Nullptr is passed in
         */
        virtual void AddEmployee(Employee const* empl) override;

        /**
         * \brief Gets the current size of the company.
         *
         * \return Size of the company
         */
        virtual size_t GetCompanySize() const override;

        /**
         * \brief Get the Count of a specific Worker Type.
         *
         * \param workerType Worker Type from which the count should be determined
         * \return Count of the Worker Type in the Company
         */
        virtual size_t GetWorkerCount(const TWorker& workerType) const override;
```

```
74
75          /**
76           * \brief Get the amount of Sold Items in the whole company.
77           *
78           * \return Amout of Sold Items
79           */
80          virtual size_t GetSoldItems() const override;
81
82          /**
83           * \brief Get the amount of produced items.
84           *
85           * \return Amout of produced Items
86           */
87          virtual size_t GetProducedItems() const override;
88
89          /**
90           * \brief Get the of worker with birth date bevor date.
91           *
92           * \param date to get the employees which are older
93           * \return Amout of employees which are older than the passed in birthdate
94           */
95          virtual size_t GetCountWorkerBeforDate(const TDate& date) const override;
96
97          /**
98           * \brief Find a worker with a specific ID.
99           *
100          * \param id ID for which should be searched for
101          * \return nullptr if no Empl is found
102          * \return Pointer to Employee
103          */
104         virtual Employee const * FindWorkerByID(const std::string& id) const override;
105
106         /**
107          * \brief Get the Employee which has been the longest serving.
108          *
109          * \return nullptr if company is empty
110          * \return Pointer to Employee
111          */
112         virtual Employee const * GetLongestServing(void) const override;
113
114         /**
115          * \brief Prints a Datasheet for each employee.
116          *
117          * \param ost ostream where the Datasheet should be printed at
118          * \return referenced ostream
119          */
120         virtual std::ostream& PrintDataSheet(std::ostream& ost) const override;
121
122         /**
123          * \brief DTOR of the Company.
124          *
125          */
126         ~Company();
127
128 private:
129
130         std::string m_companyName;
131         TContEmployee m_Employees;
132 };
133
134 #endif // !COMPANY_HPP
```

6.6 Company.cpp

```cpp
/*****************************************************************//**
 * \file   Company.hpp
 * \brief  Company that holds Employees and provides information about the
 * \brief  Employees of the company.
 *
 * \author Simon Offenberger
 * \date   October 2025
 *********************************************************************/
#include <algorithm>
#include <numeric>
#include <iostream>
#include "Company.hpp"
#include "Employee.hpp"
using namespace std;

/**
 * \brief Ostream manipulater for creating a horizontal line.
 *
 * \return string
 */
static ostream & hline(ostream & ost) {

	ost << string(60, '-') << endl;
	return ost;
}

/**
 * \brief Ostream manipulater for creating a horizontal line.
 *
 * \return string
 */
static ostream & hstar(ostream & ost) {

	ost << string(60, '*') << endl;
	return ost;
}

void Company::AddEmployee(Employee const* empl)
{
	if (empl == nullptr) throw Object::ERROR_NULLPTR;
	// insert returns a pair. First = Iterator, Second bool -> bool indicates if the insertion was succsessful.
	if (!m_Employees.insert({ empl->GetID(),empl }).second) throw Company::ERROR_DUPLICATE_EMPL;
}

Company::Company(const Company& comp)
{
	// copy Company name
	m_companyName = comp.m_companyName;

	// clone all employees from one company to the other
	for_each(
		comp.m_Employees.cbegin(), comp.m_Employees.cend(),
		[&](auto& e) {AddEmployee(e.second->Clone());
		});
}

void Company::operator=(Company comp)
{
	std::swap(m_Employees, comp.m_Employees);
	std::swap(m_companyName, comp.m_companyName);
}

size_t Company::GetCompanySize() const
{
	return m_Employees.size();
}

size_t Company::GetWorkerCount(const TWorker& workerType) const
{
	// Count all Employees where workerType is equal
	return count_if(m_Employees.cbegin(), m_Employees.cend(),
		[&](auto& e) {return e.second->GetWorkerType() == workerType;});
}
```

```
74
75  size_t Company::GetSoldItems() const
76  {
77          return accumulate(m_Employees.cbegin(), m_Employees.cend(),static_cast<size_t>(0),
78                  [](size_t val, const auto& e) { return val + e.second->GetSoldItems();});
79  }
80
81  size_t Company::GetProducedItems() const
82  {
83          return accumulate(m_Employees.cbegin(), m_Employees.cend(), static_cast<size_t>(0),
84                  [](size_t val, const auto& e) { return val + e.second->GetProducedItems();});
85  }
86
87  size_t Company::GetCountWorkerBeforDate(const TDate& date) const
88  {
89          return count_if(m_Employees.cbegin(), m_Employees.cend(),
90                  [&](const auto& e) {return e.second->GetDateBirth() < date;});
91  }
92
93  Employee const * Company::FindWorkerByID(const std::string& id) const
94  {
95          auto empl = m_Employees.find(id);
96
97          if (empl == m_Employees.end()) return nullptr;
98          else return empl->second;
99  }
100
101 Employee const * Company::GetLongestServing(void) const
102 {
103         auto minElem = min_element(m_Employees.cbegin(), m_Employees.cend(),
104                 [](const auto& lhs, const auto& rhs) { return lhs.second->GetDateJoined() < rhs.second->GetDateJoined();});
105
106         if (minElem == m_Employees.end()) return nullptr;
107         else return minElem->second;
108
109 }
110
111 std::ostream& Company::PrintDataSheet(std::ostream& ost) const
112 {
113
114         // convert system clock.now to days -> this can be used in CTOR for year month day
115         std::chrono::year_month_day date{ floor<std::chrono::days>(std::chrono::system_clock::now()) };
116
117         if (!ost.good()) throw Object::ERROR_BAD_OSTREAM;
118
119         ost << hstar;
120         ost << m_companyName << endl;
121         ost << hstar;
122
123         for_each(m_Employees.cbegin(), m_Employees.cend(), [&](const auto& e) { e.second->PrintDatasheet(ost);});
124
125         ost << hline;
126         ost << date.month() << "␣" << date.year() << endl;
127         ost << hline;
128
129         if (ost.fail()) throw Object::ERROR_FAIL_WRITE;
130
131         return ost;
132 }
133
134 Company::~Company()
135 {
136         for (auto & elem : m_Employees)
137         {
138                 delete elem.second;
139         }
140
141         m_Employees.clear();
142 }
```

6.7 TWorker.hpp

```
/*****************************************************************//**
 * \file   TWorker.hpp
 * \brief  Enum for indicating the worker Type
 *
 * \author Simon
 * \date   October 2025
 *********************************************************************/
#ifndef TWORKER_HPP
#define TWORKER_HPP

// changed naming convention because of
// name clashes with the actual classes
// that had the same name.
enum TWorker
{
    E_Boss,
    E_CommisionWorker,
    E_HourlyWorker,
    E_PieceWorker
};

#endif // !TWORKER_HPP
```

6.8 Employee.hpp

```
/*****************************************************************//**
 * \file   Employee.hpp
 * \brief
 *
 * \author Simon
 * \date   October 2025
 *********************************************************************/
#ifndef EMPLOYEE_H
#define EMPLOYEE_H

#include <string>
#include <chrono>
#include "Object.hpp"
#include "TWorker.hpp"

using TDate = std::chrono::year_month_day;

class Employee : public Object
{
public:

    inline static const std::string ERROR_BAD_ID = "ERROR: An employees ID is limited to 3 characters.";
    inline static const std::string ERROR_BAD_SOZIAL_SEC_NUM = "ERROR: Invalid Sozial Security Number";

    std::string GetID() const;

    /**
     * \brief Constructor needs every
     * member set to be called.
     * \return TWorker enum
     */
    Employee(
        std::string     name,
        std::string     nameID,
        TDate           dateJoined,
        TDate           TDateBirthdaydateBirth,
        std::string     socialSecurityNumber
    );

    /**
     * \brief Gives Information about what kind
     * of Worker it is.
     * \return TWorker enum
     */
    virtual TWorker GetWorkerType() const = 0;

    /** Pure Virtual Function
     * \brief return produced items.
     * \return size_t
     */
    virtual size_t GetProducedItems() const = 0;

    /** Pure Virtual Function
     * \brief returns sold items
     * \return size_t
     */
    virtual size_t GetSoldItems() const = 0;

    /** Pure Virtual Function
     * \brief returns total pay a worker
     * recieves.
     * \return size_t
     */
    virtual size_t GetSalary() const = 0;

    /** Pure Virtual Function
     * \brief returns date of birth of a given worker.
     * \return TDate
     */
    virtual TDate GetDateBirth() const;

    /** Pure Virtual Function
     * \brief returns the date a worker.
```

```
74          * has started working at the company.
75          * \return TDate
76          */
77         virtual TDate GetDateJoined() const;
78
79         /**
80          * \brief Prints information about a worker.
81          * \return std::ostream&
82          */
83         std::ostream& PrintDatasheet(std::ostream& ost) const;
84
85
86
87         /** Pure virtual function
88         * \brief creates a copy of the worker and puts it on the heap.
89         * \return Employee*
90         */
91         virtual Employee* Clone() const = 0;
92
93
94     protected:
95
96         /** Pure virtual function
97         * \brief Prints specific information for a type of worker.
98         * \return std::ostream&
99         */
100        virtual std::ostream& PrintSpecificData(std::ostream& ost) const = 0;
101
102        std::string m_name;
103        std::string m_nameIdentifier;
104        TDate m_dateJoined;
105        TDate m_dateBirth;
106        std::string m_socialSecurityNumber;
107
108    private:
109        const size_t SozialSecNumLen = 4;
110    };
111
112    #endif // EMPLOYEE_H
```

6.9 Employee.cpp

```cpp
/*****************************************************************//**
 * \file   Employee.hpp
 * \brief
 *
 * \author Simon
 * \date   October 2025
 *********************************************************************/
#include "Employee.hpp"
#include <cctype>
#include <algorithm>

Employee::Employee(
    std::string     name,
    std::string     nameID,
    TDate       dateJoined,
    TDate   dateBirth,
    std::string     socialSecurityNumber
) : m_name{ name },
m_nameIdentifier{ nameID },
m_dateJoined{ dateJoined },
m_dateBirth{ dateBirth }
{
    if (nameID.length() != 3) throw ERROR_BAD_ID;

    if (! std::all_of(socialSecurityNumber.begin(), socialSecurityNumber.end(), ::isdigit))  throw ERROR_BAD_SOZIAL_SEC_NUM;

    if (! (socialSecurityNumber.size() == SozialSecNumLen) )  throw ERROR_BAD_SOZIAL_SEC_NUM;

    m_socialSecurityNumber = socialSecurityNumber;

}

std::string Employee::GetID() const
{
    return m_nameIdentifier;
}

TDate Employee::GetDateBirth() const
{
    return m_dateBirth;
}

TDate Employee::GetDateJoined() const
{
    return m_dateJoined;
}

std::ostream& Employee::PrintDatasheet(std::ostream& ost) const
{
    if (ost.bad())
    {
        throw Object::ERROR_BAD_OSTREAM;
    }

    ost << "Datenblatt\n---------------\n";
    ost << "Name:␣" << m_name << std::endl;
    ost << "Kuerzel:␣" << m_nameIdentifier << std::endl;
    ost << "Sozialversicherungsnummer:␣" << m_socialSecurityNumber;
    ost << m_dateBirth.day() << static_cast<unsigned>(m_dateBirth.month()) << static_cast<int>(m_dateBirth.year())%100 << std::endl;
    ost << "Geburtstag:␣" << m_dateBirth << std::endl;
    ost << "Einstiegsjahr:␣" << m_dateJoined.year() << std::endl;

    PrintSpecificData(ost);

    ost << std::endl;

    return ost;
}
```

6.10 Boss.hpp

```cpp
/*****************************************************************//**
 * \file   Boss.hpp
 * \brief
 *
 * \author Simon
 * \date   October 2025
 *********************************************************************/
#ifndef BOSS_H
#define BOSS_H

#include "Employee.hpp"

class Boss : public Employee
{
public:

    Boss(
        std::string name,
        std::string nameID,
        TDate dateJoined,
        TDate dateBirth,
        std::string socialSecurityNumber,
        size_t salary
    );


    /**
     * \brief Just here because of whacky class structure.
     * Worker does not strictly produce items!
     */
    size_t GetProducedItems() const override { return 0; };

    /**
     * \brief Just here because of whacky class structure.
     * Worker Does not sell items!
     */
    size_t GetSoldItems() const override { return 0; };

    /**
    * \brief Returns the total earnings for an
    * worker in this month.
    * \return size_t
    */
    size_t GetSalary() const override;

    /**
     * \brief Returns the type of worker.
     * \return TWorker
     */
    TWorker GetWorkerType() const override;

    /**
     * \brief Creates a clone on the Heap
     * and returns a pointer.
     * \return Employee*
     */
    Employee* Clone() const override;

protected:
    /**
     * \brief Prints worker specific information
     * \param std::ostream& ost
     * \return std::ostream&
     */
    std::ostream& PrintSpecificData(std::ostream& ost) const override;

private:
    size_t m_salary;
};

#endif // BOSS_H
```

6.11 Boss.cpp

```cpp
/*****************************************************************//**
 * \file   Boss.hpp
 * \brief
 *
 * \author Simon
 * \date   October 2025
 *********************************************************************/
#include "Boss.hpp"

Boss::Boss(
    std::string name,
    std::string nameID,
    TDate dateJoined,
    TDate dateBirth,
    std::string socialSecurityNumber,
    size_t salary
) :
    Employee(name, nameID, dateJoined, dateBirth, socialSecurityNumber),
    m_salary{ salary } {}

std::ostream& Boss::PrintSpecificData(std::ostream& ost) const
{
    if (ost.bad())
    {
        throw Object::ERROR_BAD_OSTREAM;
        return ost;
    }
    ost << "Role:␣Boss" << std::endl;
    ost << "Salary:␣" << m_salary << "␣EUR" << std::endl;

    return ost;
}

size_t Boss::GetSalary() const
{
    return m_salary;
}

TWorker Boss::GetWorkerType() const
{
    return E_Boss;
}

Employee* Boss::Clone() const
{
    return new Boss{ *this };
}
```

6.12 HourlyWorker.hpp

```cpp
/*****************************************************************//**
 * \file   HourlyWorker.hpp
 * \brief
 *
 * \author Simon
 * \date   October 2025
 *********************************************************************/
#ifndef HOURLY_WORKER_HPP
#define HOURLY_WORKER_HPP

#include "Employee.hpp"

class HourlyWorker : public Employee
{
public:


    HourlyWorker(
        std::string name,
        std::string nameID,
        TDate dateJoined,
        TDate dateBirth,
        std::string socialSecurityNumber,
        size_t hourlyRate,
        size_t workedHours
    );


    /**
     * \brief Just here because of whacky class structure.
     * Worker does not strictly produce items!
     */
    size_t GetProducedItems() const override { return 0; };

    /**
     * \brief Just here because of whacky class structure.
     * Worker Does not sell items!
     */
    size_t GetSoldItems() const override { return 0; };

    /**
    * \brief Returns the total earnings for an
    * worker in this month.
    * \return size_t
    */
    size_t GetSalary() const override;

    /**
     * \brief Returns the type of worker.
     * \return TWorker
     */
    TWorker GetWorkerType() const override;

    /**
     * \brief Creates a clone on the Heap
     * and returns a pointer.
     * \return Employee*
     */
    Employee* Clone() const override;

protected:
    /**
     * \brief Prints worker specific information
     * \param std::ostream& ost
     * \return std::ostream&
     */
    std::ostream& PrintSpecificData(std::ostream& ost) const override;

private:
    size_t m_hourlyRate;
    size_t m_workedHours;
};

```

```
74 #endif // !HOURLY_WORKER_HPP
```

6.13 HourlyWorker.cpp

```cpp
/*****************************************************************//**
 * \file   HourlyWorker.hpp
 * \brief
 *
 * \author Simon
 * \date   October 2025
 *********************************************************************/
#include "HourlyWorker.hpp"

HourlyWorker::HourlyWorker(
    std::string name,
    std::string nameID,
    TDate dateJoined,
    TDate dateBirth,
    std::string socialSecurityNumber,
    size_t hourlyRate,
    size_t workedHours
) :
    Employee(name, nameID, dateJoined, dateBirth, socialSecurityNumber),
    m_hourlyRate{ hourlyRate },
    m_workedHours{ workedHours }
{}

std::ostream& HourlyWorker::PrintSpecificData(std::ostream& ost) const
{
    if (ost.bad())
    {
        throw Object::ERROR_BAD_OSTREAM;
        return ost;
    }
    ost << "Role:␣HourlyWWorker" << std::endl;
    ost << "Hourly␣rate:␣" << m_hourlyRate << "␣EUR" << std::endl;
    ost << "Hours␣worked:␣" << m_workedHours << "␣EUR" << std::endl;

    return ost;
}

size_t HourlyWorker::GetSalary() const
{
    return m_hourlyRate * m_workedHours;
}

TWorker HourlyWorker::GetWorkerType() const
{
    return E_HourlyWorker;
}

Employee* HourlyWorker::Clone() const
{
    return new HourlyWorker{*this};
}
```

6.14 PieceWorker.hpp

```cpp
/*****************************************************************//**
 * \file   PieceWorker.hpp
 * \brief
 *
 * \author Simon
 * \date   October 2025
 *********************************************************************/
#ifndef PIECE_WORKER_H
#define PIECE_WORKER_H

#include "Employee.hpp"

class PieceWorker : public Employee
{
public:


    PieceWorker(
        std::string name,
        std::string nameID,
        TDate dateJoined,
        TDate dateBirth,
        std::string socialSecurityNumber,
        size_t m_numberPieces,
        size_t m_commisionPerPiece
    );


    /**
     * \brief Returns the number of pieces the
     * worker has produced
     */
    size_t GetProducedItems() const override;

    /**
     * \brief Just here because of whacky class structure.
     * Worker does not strictly sell items!
     */
    size_t GetSoldItems() const override { return 0; };

    /**
    * \brief Returns the total earnings for an
    * worker in this month.
    * \return size_t
    */
    size_t GetSalary() const override;

    /**
     * \brief Returns the type of worker.
     * \return TWorker
     */
    TWorker GetWorkerType() const override;

    /**
     * \brief Creates a clone on the Heap
     * and returns a pointer.
     * \return Employee*
     */
    Employee* Clone() const override;

protected:
    /**
     * \brief Prints worker specific information
     * \param std::ostream& ost
     * \return std::ostream&
     */
    std::ostream& PrintSpecificData(std::ostream& ost) const override;

private:
    size_t m_numberPieces;
    size_t m_commisionPerPiece;
};

```

```
74 #endif // !PIECE_WORKER_H
```

6.15 PieceWorker.cpp

```cpp
/*****************************************************************//**
 * \file   PieceWorker.hpp
 * \brief
 *
 * \author Simon
 * \date   October 2025
 *********************************************************************/
#include "PieceWorker.hpp"

PieceWorker::PieceWorker(
    std::string name,
    std::string nameID,
    TDate dateJoined,
    TDate dateBirth,
    std::string socialSecurityNumber,
    size_t m_numberPieces,
    size_t m_commisionPerPiece
) :
    Employee(name, nameID, dateJoined, dateBirth, socialSecurityNumber),
    m_numberPieces{ m_numberPieces },
    m_commisionPerPiece{ m_commisionPerPiece }{}

std::ostream& PieceWorker::PrintSpecificData(std::ostream& ost) const
{
    if (ost.bad())
    {
        throw Object::ERROR_BAD_OSTREAM;
        return ost;
    }
    ost << "Role: PieceWorker" << std::endl;
    ost << "Pieces produced: " << m_numberPieces << std::endl;
    ost << "Pay per piece: " << m_commisionPerPiece << " EUR" << std::endl;

    return ost;
}

size_t PieceWorker::GetProducedItems() const
{
    return m_numberPieces;
}

size_t PieceWorker::GetSalary() const
{
    return m_numberPieces * m_commisionPerPiece;
}

TWorker PieceWorker::GetWorkerType() const
{
    return E_PieceWorker;
}

Employee* PieceWorker::Clone() const
{
    return new PieceWorker{ *this };
}
```

6.16 ComissionWorker.hpp

```cpp
/*****************************************************************//**
 * \file   ComissionWorker.hpp
 * \brief
 *
 * \author Simon
 * \date   October 2025
 *********************************************************************/
#ifndef COMISSION_WORKER_H
#define COMISSION_WORKER_H

#include "Employee.hpp"

class ComissionWorker : public Employee
{
public:

    ComissionWorker(
        std::string name,
        std::string nameID,
        TDate dateJoined,
        TDate dateBirth,
        std::string socialSecurityNumber,
        size_t baseSalary,
        size_t commisionPerPiece,
        size_t piecesSold
    );

    /**
     * \brief Just here because of whacky class structure.
     * Worker does not strictly produce items!
     */
    size_t GetProducedItems() const override { return 0; };

    /**
     * \brief returns how many items the commision worker has sold
     * \return size_t sold items
     */
    size_t GetSoldItems() const override;

    /**
    * \brief Returns the total earnings for an
    * worker in this month.
    * \return size_t
    */
    size_t GetSalary() const override;

    /**
     * \brief Returns the type of worker.
     * \return TWorker
     */
    TWorker GetWorkerType() const override;

    /**
     * \brief Creates a clone on the Heap
     * and returns a pointer.
     * \return Employee*
     */
    Employee* Clone() const override;

protected:
    /**
     * \brief Prints worker specific information
     * \param std::ostream& ost
     * \return std::ostream&
     */
    std::ostream& PrintSpecificData(std::ostream& ost) const override;

private:
    size_t m_baseSalary;
    size_t m_commisionPerPiece;
    size_t m_piecesSold;
};

```

```
74 #endif // !COMISSION_WORKER_H
```

6.17 ComissionWorker.cpp

```cpp
/*****************************************************************//**
 * \file   ComissionWorker.hpp
 * \brief
 *
 * \author Simon
 * \date   October 2025
 *********************************************************************/
#include "ComissionWorker.hpp"

ComissionWorker::ComissionWorker(
    std::string name,
    std::string nameID,
    TDate dateJoined,
    TDate dateBirth,
    std::string socialSecurityNumber,
    size_t baseSalary,
    size_t commisionPerPiece,
    size_t piecesSold
) :
    Employee(name, nameID, dateJoined, dateBirth, socialSecurityNumber),
    m_baseSalary{ baseSalary },
    m_commisionPerPiece{ commisionPerPiece },
    m_piecesSold { piecesSold }
{}

std::ostream& ComissionWorker::PrintSpecificData(std::ostream & ost) const
{
    if (ost.bad())
    {
        throw Object::ERROR_BAD_OSTREAM;
        return ost;
    }
    ost << "Role: ComissionWorker" << std::endl;
    ost << "Base salary: " << m_baseSalary << " EUR" << std::endl;
    ost << "Comission per piece: " << m_commisionPerPiece << " EUR" << std::endl;
    ost << "Pieces sold: " << m_piecesSold << std::endl;

    return ost;
}

size_t ComissionWorker::GetSoldItems() const
{
    return m_piecesSold;
}

size_t ComissionWorker::GetSalary() const
{
    return m_baseSalary + m_piecesSold * m_commisionPerPiece;
}

TWorker ComissionWorker::GetWorkerType() const
{
    return E_CommisionWorker;
}

Employee* ComissionWorker::Clone() const
{
    return new ComissionWorker{ *this };
}
```

6.18 main.cpp

```cpp
/*****************************************************************//**
 * \file   main.cpp
 * \brief  Testdriver for the Company
 *
 * \author Simon
 * \date   October 2025
 *********************************************************************/
#include "Company.hpp"
#include "Employee.hpp"
#include "HourlyWorker.hpp"
#include "vld.h"
#include "Client.hpp"
#include "Test.hpp"
#include "ComissionWorker.hpp"
#include "HourlyWorker.hpp"
#include "Boss.hpp"
#include "PieceWorker.hpp"
#include <iostream>
#include <fstream>
#include <cassert>

using namespace std;
using namespace std::chrono;

static bool TestEmployeeBoss(std::ostream& ost);
static bool TestEmployeeHourlyWorker(std::ostream& ost);
static bool TestEmployeePieceWorker(std::ostream& ost);
static bool TestEmployeeComissionWorker(std::ostream& ost);
static bool TestCompanyAdd(std::ostream& ost);

#define WRITE_OUTPUT true

int main(void){
        bool TestOK = true;
        ofstream testoutput;

        if (WRITE_OUTPUT == true) {
                testoutput.open("TestOutput.txt");
        }

         Company comp{"Offenberger Devices"};
         Client TestClient;

         ComissionWorker* cWork = new ComissionWorker{ "Simon 1", "Si1", { 2022y,November,23d }, { 2000y,November,22d }, "4711", 2500, 25, 2500 };
         ComissionWorker* cWork2 = new ComissionWorker{ "Simon 6", "Si6", { 2022y,November,23d }, { 2000y,November,22d }, "4711", 2500, 25, 200 };
         HourlyWorker* hWork = new HourlyWorker{ "Simon 2", "Si2", { 2022y,November,23d }, { 1934y,November,23d },"4712",20,25 };
         Boss* boss = new Boss{ "Simon 3", "Si3", { 2000y,November,23d }, { 1950y,November,23d },"4712",35000 };
         PieceWorker* pWork = new PieceWorker{ "Simon 4", "Si4", { 2022y,November,23d }, { 2010y,November,23d },"4712",25,25 };
         PieceWorker* pWork2 = new PieceWorker{ "Simon 5", "Si5", { 2022y,November,23d }, { 2011y,November,23d },"4712",25,25 };

         comp.AddEmployee(cWork);
         comp.AddEmployee(cWork2);
         comp.AddEmployee(hWork);
         comp.AddEmployee(boss);
         comp.AddEmployee(pWork);
         comp.AddEmployee(pWork2);

         TestOK = TestOK && TestClient.TestCompanyGetter(cout, comp);
         if(WRITE_OUTPUT) TestOK = TestOK && TestClient.TestCompanyGetter(testoutput, comp);

         // Copy Ctor Call !
         Company compCopy = comp;

         TestOK = TestOK && TestClient.TestCompanyCopyCTOR(cout, comp, compCopy);
         if (WRITE_OUTPUT) TestOK = TestOK && TestClient.TestCompanyCopyCTOR(testoutput, comp, compCopy);

         // Test Assign Operator
         Company compAss{"Assign Company"};
         compAss = comp;

         TestOK = TestOK && TestClient.TestCompanyAssignOp(cout, comp, compAss);
         if (WRITE_OUTPUT) TestOK = TestOK && TestClient.TestCompanyAssignOp(testoutput, comp, compAss);

```

```
74
75          TestOK = TestOK && TestClient.TestCompanyPrint(cout, comp);
76          if (WRITE_OUTPUT) TestOK = TestOK && TestClient.TestCompanyPrint(testoutput, comp);
77
78          Company emptyComp{"empty"};
79
80          TestOK = TestOK && TestClient.TestEmptyCompanyGetter(cout, emptyComp);
81          if (WRITE_OUTPUT) TestOK = TestOK && TestClient.TestEmptyCompanyGetter(testoutput, emptyComp);
82
83          // Test Boss
84          TestOK = TestOK && TestEmployeeBoss(cout);
85          if (WRITE_OUTPUT) TestOK = TestOK && TestEmployeeBoss(testoutput);
86
87          // Test Hourly Worker
88          TestOK = TestOK && TestEmployeeHourlyWorker(cout);
89          if (WRITE_OUTPUT) TestOK = TestOK && TestEmployeeHourlyWorker(testoutput);
90
91          // Test Piece Worker
92          TestOK = TestOK && TestEmployeePieceWorker(cout);
93          if (WRITE_OUTPUT) TestOK = TestOK && TestEmployeePieceWorker(testoutput);
94
95          // Test Comission Worker
96          TestOK = TestOK && TestEmployeeComissionWorker(cout);
97          if (WRITE_OUTPUT) TestOK = TestOK && TestEmployeeComissionWorker(testoutput);
98
99          // Test Company Add
100         TestOK = TestOK && TestCompanyAdd(cout);
101         if (WRITE_OUTPUT) TestOK = TestOK && TestCompanyAdd(testoutput);
102
103         if (WRITE_OUTPUT){
104                 if (TestOK) TestCaseOK(testoutput);
105                 else TestCaseFail(testoutput);
106
107                 testoutput.close();
108         }
109
110         if (TestOK) TestCaseOK(cout);
111         else TestCaseFail(cout);
112
113 }
114
115
116
117 static bool TestEmployeeBoss(std::ostream& ost)
118 {
119
120         assert(ost.good());
121
122         TestStart(ost);
123
124         bool TestOK = true;
125         string error_msg = "";
126
127         try {
128                 size_t testSalary = 7800;
129                 string svr = "4711";
130                 TDate dateBorn = { 2000y,November,22d };
131                 TDate dateJoined = { 2022y,November,23d };
132                 string name = "Max␣Musterman";
133                 string id = "MAX";
134
135                 Boss testBoss{ name, id, dateJoined, dateBorn, svr, testSalary };
136
137                 TestOK = TestOK && check_dump(ost, "Test␣-␣Boss.GetSalary()", testSalary, testBoss.GetSalary());
138                 TestOK = TestOK && check_dump(ost, "Test␣-␣Boss.GetSoldItems()", static_cast<size_t>(0), testBoss.GetSoldItems());
139                 TestOK = TestOK && check_dump(ost, "Test␣-␣Boss.GetProducedItems()", static_cast<size_t>(0), testBoss.GetProducedItems());
140                 TestOK = TestOK && check_dump(ost, "Test␣-␣Boss.GetWorkerType()", E_Boss, testBoss.GetWorkerType());
141                 TestOK = TestOK && check_dump(ost, "Test␣-␣Boss.GetDateBirth()", dateBorn, testBoss.GetDateBirth());
142                 TestOK = TestOK && check_dump(ost, "Test␣-␣Boss.GetDateJoined()", dateJoined, testBoss.GetDateJoined());
143         }
144         catch (const string& err) {
145                 error_msg = err;
146         }
147         catch (bad_alloc const& error) {
148                 error_msg = error.what();
149         }
```

```
150         catch (const exception& err) {
151                 error_msg = err.what();
152         }
153         catch (...) {
154                 error_msg = "Unhandelt Exception";
155         }
156
157         TestOK = TestOK && check_dump(ost, "Test - error buffer", error_msg.empty(), true);
158         error_msg.clear();
159
160         //clone test
161         try {
162                 size_t testSalary = 7800;
163                 string svr = "4711";
164                 TDate dateBorn = { 2000y,November,22d };
165                 TDate dateJoined = { 2022y,November,23d };
166                 string name = "Max Musterman";
167                 string id = "MAX";
168
169                 Boss testBoss{ name, id, dateJoined, dateBorn, svr, testSalary };
170                 Employee* pEmp = testBoss.Clone();
171                 TestOK = TestOK && check_dump(ost, "Test Boss.Clone()", pEmp != nullptr && pEmp != &testBoss, true);
172                 delete pEmp;
173         }
174         catch (const string& err) {
175                 error_msg = err;
176         }
177         catch (bad_alloc const& error) {
178                 error_msg = error.what();
179         }
180         catch (const exception& err) {
181                 error_msg = err.what();
182         }
183         catch (...) {
184                 error_msg = "Unhandelt Exception";
185         }
186
187         TestOK = TestOK && check_dump(ost, "Test - error buffer", error_msg.empty(), true);
188         error_msg.clear();
189
190         // Unavialable ID
191         try {
192                 size_t testSalary = 7800;
193                 string svr = "4711";
194                 TDate dateBorn = { 2000y,November,22d };
195                 TDate dateJoined = { 2022y,November,23d };
196                 string name = "Max Musterman";
197                 string id = "MAXL";
198
199                 Boss testBoss{ name, id, dateJoined, dateBorn, svr, testSalary };
200         }
201         catch (const string& err) {
202                 error_msg = err;
203         }
204         catch (bad_alloc const& error) {
205                 error_msg = error.what();
206         }
207         catch (const exception& err) {
208                 error_msg = err.what();
209         }
210         catch (...) {
211                 error_msg = "Unhandelt Exception";
212         }
213
214         TestOK = TestOK && check_dump(ost, "Boss Constructor bad ID", error_msg, Employee::ERROR_BAD_ID);
215         error_msg.clear();
216
217         // Constructor bad SV
218         try {
219                 size_t testSalary = 7800;
220                 string svr = "ARGH";
221                 TDate dateBorn = { 2000y,November,22d };
222                 TDate dateJoined = { 2022y,November,23d };
223                 string name = "Max Musterman";
224                 string id = "MAX";
225
```

```
226                 Boss testBoss{ name, id, dateJoined, dateBorn, svr, testSalary };
227         }
228         catch (const string& err) {
229                 error_msg = err;
230         }
231         catch (bad_alloc const& error) {
232                 error_msg = error.what();
233         }
234         catch (const exception& err) {
235                 error_msg = err.what();
236         }
237         catch (...) {
238                 error_msg = "Unhandelt Exception";
239         }
240
241         TestOK = TestOK && check_dump(ost, "Boss Constructor bad SV - invalid character", Employee::ERROR_BAD_SOZIAL_SEC_NUM, error_msg);
242
243         error_msg.clear();
244
245
246         // Constructor bad SV - too many nums
247         try {
248                 size_t testSalary = 7800;
249                 string svr = "ARGH";
250                 TDate dateBorn = { 2000y,November,22d };
251                 TDate dateJoined = { 2022y,November,23d };
252                 string name = "Max Musterman";
253                 string id = "MAX";
254
255                 Boss testBoss{ name, id, dateJoined, dateBorn, svr, testSalary };
256         }
257         catch (const string& err) {
258                 error_msg = err;
259         }
260         catch (bad_alloc const& error) {
261                 error_msg = error.what();
262         }
263         catch (const exception& err) {
264                 error_msg = err.what();
265         }
266         catch (...) {
267                 error_msg = "Unhandelt Exception";
268         }
269
270         TestOK = TestOK && check_dump(ost, "Boss Constructor bad SV - too many nums", Employee::ERROR_BAD_SOZIAL_SEC_NUM, error_msg);
271         error_msg.clear();
272
273         TestEnd(ost);
274         return TestOK;
275 }
276
277 static bool TestEmployeeHourlyWorker(std::ostream& ost)
278 {
279         assert(ost.good());
280
281         TestStart(ost);
282
283         bool TestOK = true;
284         string error_msg = "";
285
286         try {
287                 size_t hourlyRate = 21;
288                 size_t workedHours = 160;
289                 string svr = "4711";
290                 TDate dateBorn = { 2000y,November,22d };
291                 TDate dateJoined = { 2022y,November,23d };
292                 string name = "Max Musterman";
293                 string id = "MAX";
294
295                 HourlyWorker testHourlyWorker{ name, id, dateJoined, dateBorn, svr, hourlyRate, workedHours };
296
297                 TestOK = TestOK && check_dump(ost, "Test - HourlyWorker.GetSalary()", hourlyRate * workedHours, testHourlyWorker.GetSalary());
298                 TestOK = TestOK && check_dump(ost, "Test - HourlyWorker.GetSoldItems()", static_cast<size_t>(0), testHourlyWorker.GetSoldItems());
299                 TestOK = TestOK && check_dump(ost, "Test - HourlyWorker.GetProducedItems()", static_cast<size_t>(0), testHourlyWorker.GetProducedItems());
300                 TestOK = TestOK && check_dump(ost, "Test - HourlyWorker.GetWorkerType()", E_HourlyWorker, testHourlyWorker.GetWorkerType());
301                 TestOK = TestOK && check_dump(ost, "Test - HourlyWorker.GetDateBirth()", dateBorn, testHourlyWorker.GetDateBirth());
```

```
302             TestOK = TestOK && check_dump(ost, "Test - HourlyWorker.GetDateJoined()", dateJoined, testHourlyWorker.GetDateJoined());
303         }
304         catch (const string& err) {
305             error_msg = err;
306         }
307         catch (bad_alloc const& error) {
308             error_msg = error.what();
309         }
310         catch (const exception& err) {
311             error_msg = err.what();
312         }
313         catch (...) {
314             error_msg = "Unhandelt Exception";
315         }
316
317         TestOK = TestOK && check_dump(ost, "Test - error buffer", error_msg.empty(), true);
318         error_msg.clear();
319
320         //clone test
321         try {
322             size_t hourlyRate = 21;
323             size_t workedHours = 160;
324             string svr = "4711";
325             TDate dateBorn = { 2000y,November,22d };
326             TDate dateJoined = { 2022y,November,23d };
327             string name = "Max Musterman";
328             string id = "MAX";
329
330             HourlyWorker testHourlyWorker{ name, id, dateJoined, dateBorn, svr, hourlyRate, workedHours };
331
332             Employee* pEmp = testHourlyWorker.Clone();
333             TestOK = TestOK && check_dump(ost, "Test testPieceWorker.Clone()", pEmp != nullptr && pEmp != &testHourlyWorker, true);
334             delete pEmp;
335         }
336         catch (const string& err) {
337             error_msg = err;
338         }
339         catch (bad_alloc const& error) {
340             error_msg = error.what();
341         }
342         catch (const exception& err) {
343             error_msg = err.what();
344         }
345         catch (...) {
346             error_msg = "Unhandelt Exception";
347         }
348
349         TestOK = TestOK && check_dump(ost, "Test - error buffer", error_msg.empty(), true);
350         error_msg.clear();
351
352         // Unavialable ID
353         try {
354             size_t hourlyRate = 21;
355             size_t workedHours = 160;
356             string svr = "4711";
357             TDate dateBorn = { 2000y,November,22d };
358             TDate dateJoined = { 2022y,November,23d };
359             string name = "Max Musterman";
360             string id = "MAXL";
361
362             HourlyWorker testHourlyWorker{ name, id, dateJoined, dateBorn, svr, hourlyRate, workedHours };
363         }
364         catch (const string& err) {
365             error_msg = err;
366         }
367         catch (bad_alloc const& error) {
368             error_msg = error.what();
369         }
370         catch (const exception& err) {
371             error_msg = err.what();
372         }
373         catch (...) {
374             error_msg = "Unhandelt Exception";
375         }
376
377         TestOK = TestOK && check_dump(ost, "HourlyWorker Constructor bad ID", error_msg, Employee::ERROR_BAD_ID);
```

```
        error_msg.clear();

        // Constructor bad SV
        try {
                size_t hourlyRate = 21;
                size_t workedHours = 160;
                string svr = "ARGH";
                TDate dateBorn = { 2000y,November,22d };
                TDate dateJoined = { 2022y,November,23d };
                string name = "Max␣Musterman";
                string id = "MAX";

                HourlyWorker testHourlyWorker{ name, id, dateJoined, dateBorn, svr, hourlyRate, workedHours };
        }
        catch (const string& err) {
                error_msg = err;
        }
        catch (bad_alloc const& error) {
                error_msg = error.what();
        }
        catch (const exception& err) {
                error_msg = err.what();
        }
        catch (...) {
                error_msg = "Unhandelt␣Exception";
        }

        TestOK = TestOK && check_dump(ost, "HourlyWorker␣Constructor␣bad␣SV␣-␣invalid␣character", Employee::ERROR_BAD_SOZIAL_SEC_NUM, error_msg);

        error_msg.clear();

        // Constructor bad SV - too many nums
        try {
                size_t hourlyRate = 21;
                size_t workedHours = 160;
                string svr = "ARGH";
                TDate dateBorn = { 2000y,November,22d };
                TDate dateJoined = { 2022y,November,23d };
                string name = "Max␣Musterman";
                string id = "MAX";

                HourlyWorker testHourlyWorker{ name, id, dateJoined, dateBorn, svr, hourlyRate, workedHours };
        }
        catch (const string& err) {
                error_msg = err;
        }
        catch (bad_alloc const& error) {
                error_msg = error.what();
        }
        catch (const exception& err) {
                error_msg = err.what();
        }
        catch (...) {
                error_msg = "Unhandelt␣Exception";
        }

        TestOK = TestOK && check_dump(ost, "HourlyWorker␣Constructor␣bad␣SV␣-␣too␣many␣nums", Employee::ERROR_BAD_SOZIAL_SEC_NUM, error_msg);
        error_msg.clear();

        TestEnd(ost);
        return TestOK;
}

static bool TestEmployeePieceWorker(std::ostream& ost)
{
        assert(ost.good());

        TestStart(ost);

        bool TestOK = true;
        string error_msg = "";

        try {
                size_t piecesProduced = 950;
                size_t comissionPerPiece = 2;
                string svr = "4711";
```

```
454             TDate dateBorn = { 2000y,November,22d };
455             TDate dateJoined = { 2022y,November,23d };
456             string name = "Max Musterman";
457             string id = "MAX";
458
459             PieceWorker testHourlyWorker{ name, id, dateJoined, dateBorn, svr, piecesProduced, comissionPerPiece };
460
461             TestOK = TestOK && check_dump(ost, "Test - PieceWorker.GetSalary()", piecesProduced * comissionPerPiece, testHourlyWorker.GetSalary());
462             TestOK = TestOK && check_dump(ost, "Test - PieceWorker.GetSoldItems()", static_cast<size_t>(0), testHourlyWorker.GetSoldItems());
463             TestOK = TestOK && check_dump(ost, "Test - PieceWorker.GetProducedItems()", piecesProduced, testHourlyWorker.GetProducedItems());
464             TestOK = TestOK && check_dump(ost, "Test - PieceWorker.GetWorkerType()", E_PieceWorker, testHourlyWorker.GetWorkerType());
465             TestOK = TestOK && check_dump(ost, "Test - PieceWorker.GetDateBirth()", dateBorn, testHourlyWorker.GetDateBirth());
466             TestOK = TestOK && check_dump(ost, "Test - PieceWorker.GetDateJoined()", dateJoined, testHourlyWorker.GetDateJoined());
467     }
468     catch (const string& err) {
469             error_msg = err;
470     }
471     catch (bad_alloc const& error) {
472             error_msg = error.what();
473     }
474     catch (const exception& err) {
475             error_msg = err.what();
476     }
477     catch (...) {
478             error_msg = "Unhandelt Exception";
479     }
480
481     TestOK = TestOK && check_dump(ost, "Test - error buffer", error_msg.empty(), true);
482     error_msg.clear();
483
484     //clone test
485     try {
486             size_t piecesProduced = 950;
487             size_t comissionPerPiece = 2;
488             string svr = "4711";
489             TDate dateBorn = { 2000y,November,22d };
490             TDate dateJoined = { 2022y,November,23d };
491             string name = "Max Musterman";
492             string id = "MAX";
493
494             PieceWorker testPieceWorker{ name, id, dateJoined, dateBorn, svr, piecesProduced, comissionPerPiece };
495             Employee* pEmp = testPieceWorker.Clone();
496             TestOK = TestOK && check_dump(ost, "Test testPieceWorker.Clone()", pEmp != nullptr && pEmp != &testPieceWorker, true);
497             delete pEmp;
498     }
499     catch (const string& err) {
500             error_msg = err;
501     }
502     catch (bad_alloc const& error) {
503             error_msg = error.what();
504     }
505     catch (const exception& err) {
506             error_msg = err.what();
507     }
508     catch (...) {
509             error_msg = "Unhandelt Exception";
510     }
511
512     TestOK = TestOK && check_dump(ost, "Test - error buffer", error_msg.empty(), true);
513     error_msg.clear();
514
515     // Unavialable ID
516     try {
517             size_t piecesProduced = 950;
518             size_t comissionPerPiece = 2;
519             string svr = "4711";
520             TDate dateBorn = { 2000y,November,22d };
521             TDate dateJoined = { 2022y,November,23d };
522             string name = "Max Musterman";
523             string id = "MAXL";
524
525             PieceWorker testPieceWorker{ name, id, dateJoined, dateBorn, svr, piecesProduced, comissionPerPiece };
526     }
527     catch (const string& err) {
528             error_msg = err;
529     }
```

```
530         catch (bad_alloc const& error) {
531                 error_msg = error.what();
532         }
533         catch (const exception& err) {
534                 error_msg = err.what();
535         }
536         catch (...) {
537                 error_msg = "Unhandelt Exception";
538         }
539
540         TestOK = TestOK && check_dump(ost, "PieceWorker Constructor bad ID", error_msg, Employee::ERROR_BAD_ID);
541         error_msg.clear();
542
543         // Constructor bad SV
544         try {
545                 size_t piecesProduced = 950;
546                 size_t comissionPerPiece = 2;
547                 string svr = "ARGH";
548                 TDate dateBorn = { 2000y,November,22d };
549                 TDate dateJoined = { 2022y,November,23d };
550                 string name = "Max Musterman";
551                 string id = "MAX";
552
553                 PieceWorker testPieceWorker{ name, id, dateJoined, dateBorn, svr, piecesProduced, comissionPerPiece };
554         }
555         catch (const string& err) {
556                 error_msg = err;
557         }
558         catch (bad_alloc const& error) {
559                 error_msg = error.what();
560         }
561         catch (const exception& err) {
562                 error_msg = err.what();
563         }
564         catch (...) {
565                 error_msg = "Unhandelt Exception";
566         }
567
568         TestOK = TestOK && check_dump(ost, "PieceWorker Constructor bad SV - invalid character", Employee::ERROR_BAD_SOZIAL_SEC_NUM, error_msg);
569
570         error_msg.clear();
571
572         // Constructor bad SV - too many nums
573         try {
574                 size_t piecesProduced = 950;
575                 size_t comissionPerPiece = 2;
576                 string svr = "ARGH";
577                 TDate dateBorn = { 2000y,November,22d };
578                 TDate dateJoined = { 2022y,November,23d };
579                 string name = "Max Musterman";
580                 string id = "MAX";
581
582                 PieceWorker testPieceWorker{ name, id, dateJoined, dateBorn, svr, piecesProduced, comissionPerPiece };
583         }
584         catch (const string& err) {
585                 error_msg = err;
586         }
587         catch (bad_alloc const& error) {
588                 error_msg = error.what();
589         }
590         catch (const exception& err) {
591                 error_msg = err.what();
592         }
593         catch (...) {
594                 error_msg = "Unhandelt Exception";
595         }
596
597         TestOK = TestOK && check_dump(ost, "PieceWorker Constructor bad SV - too many nums", Employee::ERROR_BAD_SOZIAL_SEC_NUM, error_msg);
598         error_msg.clear();
599
600
601         TestEnd(ost);
602         return TestOK;
603 }
604
605 static bool TestEmployeeComissionWorker(std::ostream& ost)
```

```
606 {
607         assert(ost.good());
608 
609         TestStart(ost);
610 
611         bool TestOK = true;
612         string error_msg = "";
613 
614         try {
615                 size_t baseSalary = 2300;
616                 size_t piecesSold = 300;
617                 size_t comissionPerPiece = 2;
618                 string svr = "4711";
619                 TDate dateBorn = { 2000y,November,22d };
620                 TDate dateJoined = { 2022y,November,23d };
621                 string name = "Max␣Musterman";
622                 string id = "MAX";
623 
624                 ComissionWorker testHourlyWorker{ name, id, dateJoined, dateBorn, svr, baseSalary, comissionPerPiece, piecesSold };
625 
626                 TestOK = TestOK && check_dump(ost, "Test␣-␣ComissionWorker.GetSalary()", baseSalary + piecesSold * comissionPerPiece, testHourlyWorker.GetSalary());
627                 TestOK = TestOK && check_dump(ost, "Test␣-␣ComissionWorker.GetSoldItems()", piecesSold, testHourlyWorker.GetSoldItems());
628                 TestOK = TestOK && check_dump(ost, "Test␣-␣ComissionWorker.GetProducedItems()", static_cast<size_t>(0), testHourlyWorker.GetProducedItems());
629                 TestOK = TestOK && check_dump(ost, "Test␣-␣ComissionWorker.GetWorkerType()", E_CommisionWorker, testHourlyWorker.GetWorkerType());
630                 TestOK = TestOK && check_dump(ost, "Test␣-␣ComissionWorker.GetDateBirth()", dateBorn, testHourlyWorker.GetDateBirth());
631                 TestOK = TestOK && check_dump(ost, "Test␣-␣ComissionWorker.GetDateJoined()", dateJoined, testHourlyWorker.GetDateJoined());
632         }
633         catch (const string& err) {
634                 error_msg = err;
635         }
636         catch (bad_alloc const& error) {
637                 error_msg = error.what();
638         }
639         catch (const exception& err) {
640                 error_msg = err.what();
641         }
642         catch (...) {
643                 error_msg = "Unhandelt␣Exception";
644         }
645 
646         TestOK = TestOK && check_dump(ost, "Test␣-␣error␣buffer", error_msg.empty(), true);
647         error_msg.clear();
648 
649         //clone test
650         try {
651                 size_t baseSalary = 2300;
652                 size_t piecesSold = 300;
653                 size_t comissionPerPiece = 2;
654                 string svr = "4711";
655                 TDate dateBorn = { 2000y,November,22d };
656                 TDate dateJoined = { 2022y,November,23d };
657                 string name = "Max␣Musterman";
658                 string id = "MAX";
659 
660                 ComissionWorker testComissionWorker{ name, id, dateJoined, dateBorn, svr, baseSalary, comissionPerPiece, piecesSold };
661                 Employee* pEmp = testComissionWorker.Clone();
662                 TestOK = TestOK && check_dump(ost, "Test␣testPieceWorker.Clone()", pEmp != nullptr && pEmp != &testComissionWorker, true);
663                 delete pEmp;
664         }
665         catch (const string& err) {
666                 error_msg = err;
667         }
668         catch (bad_alloc const& error) {
669                 error_msg = error.what();
670         }
671         catch (const exception& err) {
672                 error_msg = err.what();
673         }
674         catch (...) {
675                 error_msg = "Unhandelt␣Exception";
676         }
677 
678         TestOK = TestOK && check_dump(ost, "Test␣-␣error␣buffer", error_msg.empty(), true);
679         error_msg.clear();
680 
681         // Unavialable ID
```

```
682         try {
683                 size_t baseSalary = 2300;
684                 size_t piecesSold = 300;
685                 size_t comissionPerPiece = 2;
686                 string svr = "4711";
687                 TDate dateBorn = { 2000y,November,22d };
688                 TDate dateJoined = { 2022y,November,23d };
689                 string name = "Max␣Musterman";
690                 string id = "MAXL";
691
692                 ComissionWorker testComissionWorker{ name, id, dateJoined, dateBorn, svr, baseSalary, comissionPerPiece, piecesSold };
693         }
694         catch (const string& err) {
695                 error_msg = err;
696         }
697         catch (bad_alloc const& error) {
698                 error_msg = error.what();
699         }
700         catch (const exception& err) {
701                 error_msg = err.what();
702         }
703         catch (...) {
704                 error_msg = "Unhandelt␣Exception";
705         }
706
707         TestOK = TestOK && check_dump(ost, "ComissionWorker␣Constructor␣bad␣ID␣", error_msg, Employee::ERROR_BAD_ID);
708         error_msg.clear();
709
710         // Constructor bad SV - no numbers
711         try {
712                 size_t baseSalary = 2300;
713                 size_t piecesSold = 300;
714                 size_t comissionPerPiece = 2;
715                 string svr = "ARGH";
716                 TDate dateBorn = { 2000y,November,22d };
717                 TDate dateJoined = { 2022y,November,23d };
718                 string name = "Max␣Musterman";
719                 string id = "MAX";
720
721                 ComissionWorker testComissionWorker{ name, id, dateJoined, dateBorn, svr, baseSalary, comissionPerPiece, piecesSold };
722         }
723         catch (const string& err) {
724                 error_msg = err;
725         }
726         catch (bad_alloc const& error) {
727                 error_msg = error.what();
728         }
729         catch (const exception& err) {
730                 error_msg = err.what();
731         }
732         catch (...) {
733                 error_msg = "Unhandelt␣Exception";
734         }
735
736         TestOK = TestOK && check_dump(ost, "ComissionWorker␣Constructor␣bad␣SV␣-␣invalid␣character", Employee::ERROR_BAD_SOZIAL_SEC_NUM, error_msg);
737
738         error_msg.clear();
739
740         // Constructor bad SV - too many nums
741         try {
742                 size_t baseSalary = 2300;
743                 size_t piecesSold = 300;
744                 size_t comissionPerPiece = 2;
745                 string svr = "47488888239874";
746                 TDate dateBorn = { 2000y,November,22d };
747                 TDate dateJoined = { 2022y,November,23d };
748                 string name = "Max␣Musterman";
749                 string id = "MAX";
750
751                 ComissionWorker testComissionWorker{ name, id, dateJoined, dateBorn, svr, baseSalary, comissionPerPiece, piecesSold };
752         }
753         catch (const string& err) {
754                 error_msg = err;
755         }
756         catch (bad_alloc const& error) {
757                 error_msg = error.what();
```

```
758         }
759         catch (const exception& err) {
760                 error_msg = err.what();
761         }
762         catch (...) {
763                 error_msg = "Unhandelt Exception";
764         }
765
766         TestOK = TestOK && check_dump(ost, "ComissionWorker Constructor bad SV - too many nums", Employee::ERROR_BAD_SOZIAL_SEC_NUM, error_msg);
767
768         error_msg.clear();
769
770         TestEnd(ost);
771         return TestOK;
772 }
773
774
775 static bool TestCompanyAdd(std::ostream& ost)
776 {
777         assert(ost.good());
778
779         TestStart(ost);
780
781         bool TestOK = true;
782         string error_msg = "";
783
784         try {
785
786                 ComissionWorker* cWork = new ComissionWorker{ "Simon 1", "Si1", { 2022y,November,23d }, { 2000y,November,22d }, "4711", 2500, 25, 2500 };
787
788                 Company comp{"Dup"};
789                 comp.AddEmployee(cWork);
790                 comp.AddEmployee(cWork);
791         }
792         catch (const string& err) {
793                 error_msg = err;
794         }
795         catch (bad_alloc const& error) {
796                 error_msg = error.what();
797         }
798         catch (const exception& err) {
799                 error_msg = err.what();
800         }
801         catch (...) {
802                 error_msg = "Unhandelt Exception";
803         }
804
805         TestOK = TestOK && check_dump(ost, "Test Exception in Company Add Duplicate", Company::ERROR_DUPLICATE_EMPL, error_msg);
806         error_msg.clear();
807
808         TestEnd(ost);
809         return TestOK;
810 }
```

6.19 Test.hpp

```
/*****************************************************************//**
 * \file   Test.hpp
 * \brief
 *
 * \author Simon
 * \date   April 2025
 *********************************************************************/
#ifndef TEST_HPP
#define TEST_HPP

#include <string>
#include <iostream>
#include <vector>
#include <list>
#include <queue>
#include <forward_list>

#define ON 1
#define OFF 0
#define COLOR_OUTPUT OFF

// Definitions of colors in order to change the color of the output stream.
const std::string colorRed = "\x1B[31m";
const std::string colorGreen = "\x1B[32m";
const std::string colorWhite = "\x1B[37m";

inline std::ostream& RED(std::ostream& ost) {
	if (ost.good()) {
		ost << colorRed;
	}
	return ost;
}
inline std::ostream& GREEN(std::ostream& ost) {
	if (ost.good()) {
		ost << colorGreen;
	}
	return ost;
}
inline std::ostream& WHITE(std::ostream& ost) {
	if (ost.good()) {
		ost << colorWhite;
	}
	return ost;
}

inline std::ostream& TestStart(std::ostream& ost) {
	if (ost.good()) {
		ost << std::endl;
		ost << "****************************************" << std::endl;
		ost << "␣␣␣␣␣␣␣␣␣␣␣␣TESTCASE␣START␣␣␣␣␣␣␣␣␣␣␣␣␣␣" << std::endl;
		ost << "****************************************" << std::endl;
		ost << std::endl;
	}
	return ost;
}

inline std::ostream& TestEnd(std::ostream& ost) {
	if (ost.good()) {
		ost << std::endl;
		ost << "****************************************" << std::endl;
		ost << std::endl;
	}
	return ost;
}

inline std::ostream& TestCaseOK(std::ostream& ost) {

#if COLOR_OUTPUT
	if (ost.good()) {
		ost << colorGreen << "TEST␣OK!!" << colorWhite << std::endl;
	}
#else
	if (ost.good()) {
```

```
74                  ost <<  "TEST␣OK!!" <<  std::endl;
75          }
76  #endif // COLOR_OUTPUT
77
78          return ost;
79  }
80
81  inline std::ostream& TestCaseFail(std::ostream& ost) {
82
83  #if COLOR_OUTPUT
84          if (ost.good()) {
85                  ost << colorRed << "TEST␣FAILED␣!!" << colorWhite << std::endl;
86
87          }
88  #else
89          if (ost.good()) {
90                  ost << "TEST␣FAILED␣!!" << std::endl;
91
92          }
93  #endif // COLOR_OUTPUT
94
95          return ost;
96  }
97
98  /**
99          * \brief function that reports if the testcase was successful.
100         *
101         * \param testcase       String that indicates the testcase
102         * \param succsessful true -> reports to cout test OK
103         * \param succsessful false -> reports test failed
104         */
105 template <typename T>
106 bool check_dump(std::ostream& ostr, const std::string& testcase, const T& expected, const T& result) {
107         if (ostr.good()) {
108 #if COLOR_OUTPUT
109                 if (expected == result) {
110                         ostr << testcase << std::endl <<  colorGreen << "[Test␣OK]␣" << colorWhite <<"Result:␣(Expected:␣" << std::boolalpha << expected << "␣==" << "␣Result:␣" << result << ")"  << std::
                                noboolalpha << std::endl << std::endl;
111                 }
112                 else {
113                         ostr << testcase << std::endl << colorRed << "[Test␣FAILED]␣" << colorWhite << "Result:␣(Expected:␣" << std::boolalpha << expected << "␣!=" << "␣Result:␣" << result << ")"  << std
                                ::noboolalpha << std::endl << std::endl;
114                 }
115 #else
116                 if (expected == result) {
117                         ostr << testcase << std::endl << "[Test␣OK]␣"  << "Result:␣(Expected:␣" << std::boolalpha << expected << "␣==" << "␣Result:␣" << result << ")" << std::noboolalpha << std::endl <<
                                std::endl;
118                 }
119                 else {
120                         ostr << testcase << std::endl  << "[Test␣FAILED]␣"  << "Result:␣(Expected:␣" << std::boolalpha << expected << "␣!=" << "␣Result:␣" << result << ")" << std::noboolalpha << std::
                                endl << std::endl;
121                 }
122 #endif
123                 if (ostr.fail()) {
124                         std::cerr << "Error:␣Write␣Ostream" << std::endl;
125                 }
126         }
127         else {
128                 std::cerr << "Error:␣Bad␣Ostream" << std::endl;
129         }
130         return expected == result;
131 }
132
133 template <typename T1, typename T2>
134 std::ostream& operator<< (std::ostream& ost,const std::pair<T1,T2> & p) {
135         if (!ost.good()) throw std::exception{ "Error␣bad␣Ostream!" };
136         ost << "(" << p.first << "," << p.second << ")";
137         return ost;
138 }
139
140 template <typename T>
141 std::ostream& operator<< (std::ostream& ost,const std::vector<T> & cont) {
142         if (!ost.good()) throw std::exception{ "Error␣bad␣Ostream!" };
143         std::copy(cont.cbegin(), cont.cend(), std::ostream_iterator<T>{ost, "␣"});
144         return ost;
145 }
```

```
146
147 template <typename T>
148 std::ostream& operator<< (std::ostream& ost,const std::list<T> & cont) {
149         if (!ost.good()) throw std::exception{ "Error␣bad␣Ostream!" };
150         std::copy(cont.cbegin(), cont.cend(), std::ostream_iterator<T>{ost, "␣"});
151         return ost;
152 }
153
154 template <typename T>
155 std::ostream& operator<< (std::ostream& ost,const std::deque<T> & cont) {
156         if (!ost.good()) throw std::exception{ "Error␣bad␣Ostream!" };
157         std::copy(cont.cbegin(), cont.cend(), std::ostream_iterator<T>{ost, "␣"});
158         return ost;
159 }
160
161 template <typename T>
162 std::ostream& operator<< (std::ostream& ost,const std::forward_list<T> & cont) {
163         if (!ost.good()) throw std::exception{ "Error␣bad␣Ostream!" };
164         std::copy(cont.cbegin(), cont.cend(), std::ostream_iterator<T>{ost, "␣"});
165         return ost;
166 }
167
168
169 #endif // !TEST_HPP
```